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DISCOVERY

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DISCOVERY

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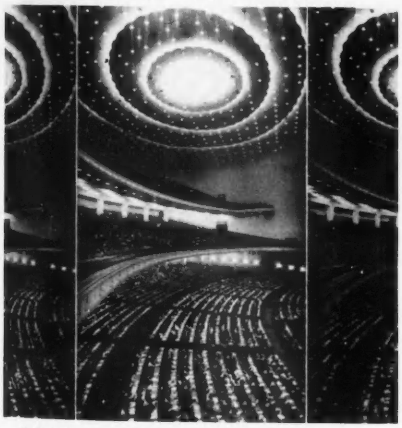


This "National Conference of Advanced Workers in Education and Culture" is a typical example of the mass techniques being used in China for the "big leap forward".

CONTENTS

INTERNATIONAL CONFERENCES—TIME FOR A CHANGE

The end of July to the beginning of October is the high season for international scientific conferences. During the current year, many of them have been held in Europe's northern capitals—Helsinki, Stockholm, Copenhagen, London, with smaller gatherings at Liège and Cambridge. The daily Press has given them more attention than it normally does, but this may have been due as much to their physical proximity as their intrinsic interest, for news editors on the whole, it must be admitted, remain better judges of travel costs than of the progress of science.

Unfortunately, the amount of coverage a given conference receives is turning out to be inversely proportional to its scientific value. The annual meeting of the International Astronautical Federation, for example, captured a great many headlines—yet it is questionable whether it was a scientific meeting at all. It appeared to be more like a platform for national, commercial, and personal propaganda. Correspondents from practically every major newspaper and news agency were on hand to cover it this year—yet only one professional science correspondent from Britain attended the triennial assembly of the International Union of Geodesy and Geophysics in Helsinki, a highly productive conference which literally covered everything under the sun.

A number of questions should be raised about international gatherings and the way they are managed. Many seem to be suffering from the onset of galloping *Parkinsonitis* in which larger and larger groups of scientists with greater and greater gobbets of paper chase each other round in ever-decreasing circles. Every year brings more conferences at which there are increasing numbers of papers given which are not heard and which will not be read when published.

There are, of course, good reasons for the recent increase in scientific meetings at the international level.

We have entered an era of geo-scientific research on a scale that is extremely expensive in terms of manpower and money. No single country seems to have enough scientists or the inclination to spend the amount of money required to carry out the research it considers necessary for its security and well-being, the U.S. and Soviet Union included. The areas to be investigated are too numerous and too vast. After all, how much can one country afford to spend on oceanography, radio-astronomy, weather research, geophysics, cancer, mental illnesses, space, seismology, nuclear physics, etc., *ad infinitum*? International co-operation is a matter of necessity and the success achieved in working together during the International Geophysical Year has prepared the way for close co-operation during the coming years. The co-ordination of the research programmes of the various nations and the eventual discussion of the findings are going to require frequent international meetings, however, so it might be wise to do some research first on how to conduct such conferences efficiently.

Interdisciplinary research poses the same problem. The areas in which two or more disciplines overlap hold out the promise of rich rewards but, unfortunately (or fortunately), there are a far greater number of combinations than there are disciplines to start with—almost half the square of the number of disciplines [$\frac{1}{2}(n)(n-1)$] if we just consider the overlap of two, and almost one-third the cube if we consider the overlap of three. Does any one country have enough scientists and money to do as much as it wants or needs to in all these areas? The answer is obvious. Co-operation among scientists round the world is the only way of achieving the most rapid progress, and international conferences will continue to be one of the best methods of communication. A few minutes of direct talk can dispense with months of letter-writing, and a corridor argument can fertilise several years of research.

The need for international meetings is apparent; it is the manner in which they are held that needs revision.

One major fault of international conferences, as they are now organised, is the amount of valuable time they waste of the important people who attend. The causes are usually trivial but the time lost adds up to at least twenty-four conference hours per gathering. Worst of all are the excruciating plenary sessions at the beginning and end, each dragging on for about three hours. At these sessions, which seem to be an essential part of all large conferences, one set of normally sensible people sit listening while another set of normally sensible people get up in rotation to mouth the most devastating platitudes or read lengthy reports of which everyone already has a copy. The sentiments expressed seldom rise to a level that would be tolerated in an undergraduate common room. How do these eminent men and women stand it and, what is much more puzzling, why?

Some changes are also called for in the traditional practice of publishing the proceedings of these conferences. The recording of an almost endless flow of words produces a massive tome that is costly to buy and even more costly to produce. Published as much as a year or two after a conference, they are practically obsolete on the day they come out and the interest in them by this time is so negligible the sponsors are usually out of pocket. What a heartbreaking and pointless business. Something really valuable and readable would be a series of authoritative review articles on each session. There is no reason why these cannot be published and available within a month. The distribution of the detailed technical papers can be left to those most intimately involved—the authors themselves. The more important papers will be of interest to the scientific journals; those which are without merit should not clutter up longer and less topical volumes.

The sociologists have begun to occupy themselves with the group dynamics of conferences but have so far succeeded only in asking more questions, not giving answers.

This matter should not be left entirely to the sociologists. It is perhaps time for an international conference on international conferences.

R.K.M.

THE PROGRESS OF SCIENCE

A CHEMICAL APPROACH TO SCHIZOPHRENIA

A new drug which produces realistic "insanity" in human volunteers is helping scientists develop therapeutic agents aimed at correcting the biochemical changes present in schizophrenia, according to a report by Dr John H. Biel to the American Chemical Society. Called JB-329, the recent compound can produce an eight- to twelve-hour psychosis "indistinguishable from the true disease". Two drugs that counteract the simulated insanity which it induces are currently undergoing clinical trials in cases of schizophrenia.

One of them, tetrahydroanibacrin, reversed the JB-329-induced psychosis in five minutes after its intravenous administration. Another compound, cyclopentimine, which was found to be antagonistic towards JB-329 in animals, brought about a substantial improvement in 50% of a variety of schizophrenics and enabled a further 20% to be discharged from mental hospital.

ORBITING DIPOLES FOR GLOBAL COMMUNICATION

The creation of a long-range communication system by placing a reflecting belt of tuned dipoles in orbit around the earth is an idea that has an attractive simplicity. Details for a system of this kind were presented by scientists from the Massachusetts Institute of Technology at the XIII Assembly of the International Radio Scientific Union (URSI) in London.

Only two orbiting dipole belts (dispersed from two satellites) would be necessary for truly global coverage. The transmitter and receiver requirements would be relatively modest. With 100 kg. of the dipole slivers distributed in a circular orbit a few thousand kilometres up, the system would only need 10 kW transmitters and conventional Maser receivers, with 60-ft. "dishes". Such a system would be capable of sending 10,000 bits/sec.

The MIT scheme calls for one belt of dipoles in an equatorial orbit and one in a polar orbit, both at altitudes of 5000 to 10,000 km. Dipoles with diameters of 0·003 cm. were suggested. One of the main considerations in the design of these hair-thin elements (shown in photo) is the perturbing effect of solar pressure.

For initial trials, the MIT scientists said the dipoles might be made of a white tin alloy that would gradually disintegrate into a grey dust from the cumulative effect of the low temperatures on the night side of the earth. By manipulating the composition of the alloy, it would apparently be possible to vary the time it takes for this to happen from six months to many years. Once in orbit, the metallic slivers would gradually spread into a belt that might be 40 km. thick after sixty days and 100 km. thick at the end of a year. The perturbations of the orbit itself would be considerably greater than this; dipoles in a polar orbit at a mean altitude of 3700 km. would gradually be forced into the atmosphere within one to one and a half years.

Typical dipoles.

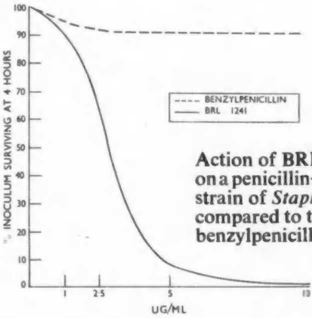
A number of astronomers have charged that such a project would be disastrous to radio and optical astronomy but the MIT researchers contend the concentration of slivers would be so sparse the interference would be negligible. Despite these assurances, delegates at the URSI meeting adopted a resolution expressing the "great concern" of the radioastronomers and urging the Union to take appropriate action against any projects which might interfere with their work.

The U.S. is making other approaches to global communication through the use of active and passive satellites. On October 5, they made the first successful launch of a *Project Courier* unit—an active-repeater capable of instantaneous or delayed transmission. The five tape-recorders and associated equipment aboard are capable of handling forty teletype channels running at 100 words a minute simultaneously. The ultimate *Courier* system envisages three "stationary" satellites and forty ground stations, and will provide 960 simultaneous channels within a 50 mc/s waveband. Although this is a military project, the knowledge and experience gained will be directly applicable in the commercial field.

A MORE EFFECTIVE PENICILLIN—BRL 1241

A notable new member of the penicillin family of drugs has been synthesised by workers at Beecham Research Laboratories, from the penicillin "nucleus", 6-aminopenicillanic acid, which they isolated last year. Chemically it is sodium 6-(2, 6 dimethoxybenzamido)penicillanate monohydrate, with the laboratory label BRL 1241 and the trade name "celbenin". Apart from being an effective antibiotic, this new derivative possesses the important property, unique in a penicillin, of being almost entirely resistant to attack by the particular variety of the enzyme, penicillinase, produced by certain types of staphylococci. As it is the tendency of these cocci to elaborate penicillinase, thereby making certain organisms resistant to antibiotics, BRL 1241 promises to be a useful addition to the few drugs which are effective against penicillin-resistant staphylococci now plaguing hospitals throughout the world.

Laboratory studies by the Beecham team and other British investigators indicate that in therapeutic doses the new substance will inhibit or kill all types of staphylococci, whether they are sensitive or resistant to antibiotics. So far, no strains of this bacterium have been found which are resistant to the drug. Nor have resistant staphylococci yet been recovered from any patient treated with BRL 1241. Like earlier, natural penicillins, the Beecham product shows relatively high activity against several other pus-forming cocci, but its main merit is its efficacy in dealing with penicillin-resistant staphylococci.



Action of BRL 1241 on a penicillin-resistant strain of *Staph. aureus* compared to that of benzylpenicillin.

Thirteen patients with purulent infections due to such organisms provided material for a clinical trial of BRL 1241 at Guy's Hospital in London. All of them had failed to respond to other forms of treatment, yet each of them was freed of

the recalcitrant staphylococci by the new drug. Encouraging results were also obtained from its use in staphylococcal and streptococcal infections of young people at Queen Mary's Hospital for Children, Carshalton. Spraying the air with the antibiotic for two minutes a day in a maternity ward at St George's Hospital, London, strikingly reduced the prevalence of staphylococci colonising the noses of infants born there. Even the ward dust was found to be free of the pyogenic staphylococci normally present.

"Wonder drugs" have their drawbacks, however. Being unstable in acid media, BRL 1241 is ineffective when taken orally and so must be administered by injection. For it to be bactericidal, comparatively high concentrations are needed in the blood, entailing intramuscular injections every four or six hours. The injections are painful, and prolonged treatment causes local reactions. Allergic manifestations have also been reported among the very few cases already treated. On the other hand, this recent compound is only the second derivative of 6-APA to attract clinical attention; by adding further side-chains to 6-APA, countless other penicillins can be synthesised. So great is the skill of the modern biochemist in tailoring his molecules, it is likely a still better penicillin will be found that does not have the disadvantages of the new preparation.

RESONANCE OF THE HUMAN BODY

Vibrations and resonance have been studied in various structures for centuries, but it is only relatively recently that man himself has been looked upon as a spring-mass system. The interest in human body resonances has been stimulated by the development of high-speed aircraft in which a pilot has to work under bumpy conditions. The RAF Institute of Aviation Medicine have carried out a number of controlled experiments to find out how body size, muscular tension, and intensity of vibration influence resonant action of the body. Measurements with accelerometers revealed spinal resonances, the most marked effect occurring at about 5 cycles/sec., with smaller effects at 2·4 and 13 cycles/sec. The 5-cycle resonance proved most uncomfortable and simple tests on the recording of printing errors and the co-ordination of hand and eye manoeuvres showed significant degradation in performance near resonance, although it was even worse below resonance, at about 4 cycles/sec.

Tests on ten men showed that variations in body size and intensity of vibration had little effect on the resonant frequencies but that muscular tensing diminished the involuntary shoulder-shrugging movements and raised the frequency slightly because it increased body damping.

It is interesting to note that the resonance induced in motor cars due to road shocks is about the same frequency as the human body. Motor manufacturers might well study these results as they may explain why certain cars give a much better ride than others, although there is no obvious difference in springing between them.

A NOTE ON AGEING—REJUVENATION CLAIMS AND MENTAL DISORDERS

The widespread public interest and medical scepticism aroused in Britain last year by newspaper reports of the rejuvenating properties of procaine are now being repeated in the U.S.A. Claims that procaine injections can relieve or cure various diseases and disorders of old age were made by Dr Anna Aslan at the fifth International Congress of Gerontology held in San Francisco. Recounting her experiences at the C.I. Parthon Institute of Geriatrics, Bucharest, Dr Aslan said that treatment with the universally used local anaesthetic—for which she has coined the name "H3"—produced favourable responses in cases of baldness, deafness, arteriosclerosis, hypertension, and spinal cord diseases among a large number of elderly patients.

Dr Aslan made the same remarkable claims for procaine "treatment" when she came to London as a guest of the *Daily Mail* to lecture to a group of gerontologists on her method. Used to subjecting novel therapeutic procedures to controlled clinical trials, the British clinicians were frankly unimpressed by the Hungarian doctor's presentation of her case. There was similar and perhaps sharper criticism of her experiments at the American meeting. Dr Nathan Shock of the National Heart Institute observed that "none of Dr Aslan's published studies has had any kind of adequate scientific control" and said that she had refused to perform a double-blind clinical trial on her work and would not allow anyone else to do so. Nor could Dr Michael Dacso, New York University, find anything in the available literature to justify optimism over procaine's ability to fulfil the purposes claimed by Dr Aslan. "Not Proven" would, therefore, seem to be a majority verdict among the medical profession as far as procaine treatment is concerned.

At the same meeting were reported the results of an inquiry into the possible origins of psychiatric disorders in the elderly. Psychiatrists and social scientists at the Langley Porter Neuropsychiatric Institute compared the histories of 530 men and women over 60 years of age who were admitted to the psychiatric ward of a general hospital with the histories of a matched group of 600 persons living in the community. (Two-thirds of the 530 men and women were actually committed to mental hospitals.) It was found that the "control" subjects in the community belonged to an appreciably higher economic group. They showed less physical illness than the hospital cases, saw their doctor more often, and had invested in more health insurance. Moreover, the controls had a higher average intelligence. Nearly all of them read every day, watched television, and listened to the radio, whereas more than half the hospital subjects said they never read and were seldom exposed to TV or radio.

continued on page 505

Flying Saucer? Not quite. Only a stationary lenticular cloud of the type produced by standing waves and eddies near mountains. Photo taken at Heard Island, Antarctica.
(Australian News and Information Bureau)

CHINA'S FORWARD LEAP IN SCIENCE

DANA WILGRESS

If the present complacency about this growing World Power continues to parallel that towards the Soviet Union during and after World War II, the West may be in for a rude awakening.

For a long period the Western world was indifferent to the stories coming out of Russia about the attention being paid by the Soviet authorities to the development of science and technology. Those visiting the Soviet Union during and immediately after the war brought back tales of how the scientists had become the élite of Soviet society, taking the place that had been occupied by the writers during the period between the wars. They had become a privileged class with important perquisites in the way of large flats, attractive summer homes, motor-cars, and everything they desired in the form of laboratory equipment. Some of the foreign visitors were taken to the engineering schools at Sverdlovsk and other places and came away impressed with the number and quality of the students attending these institutions. These tales failed to make any deep impression on Western thinking, until in October 1957 the launching of the first *Sputnik* brought about the realisation that Soviet science was capable of outstanding achievements.

Economist-Diplomat Dana Wilgress has held a number of top posts in the Canadian Government: Ambassador to the U.S.S.R., High Commissioner for Canada in the U.K., Permanent Representative to NATO, and Representative to the OEEC, among others. The material for this article was obtained during a study for OEEC.

CHINESE BID FOR SUPREMACY

The same complacency may now be observed with regard to the development of science and technology in Communist China. The leaders of that country have embarked on a programme which is aimed at outstripping what the Russians have done in this field. In the short term, this programme is characterised by great leaps forward so typical of the Communist approach. In the long term, however, this is moderated by a typically Chinese philosophical attitude. There is a realistic appreciation of the obstacles to be overcome before the final goal can be reached. While exhorting the people to great efforts in the present, the leaders have braced themselves for the long pull necessary to build upon sound foundations.

This outlook evolved in 1956 when stock was taken of the achievements of the first Five-year Plan (1953–7) of economic development. The State Scientific and Technological Commission, working out a twelve-year plan for 1956–67 that placed primary emphasis on scientific

research for economic development, soon realised that a limiting factor was the shortage of scientists and technologists. To cope with the demand, it was apparent that more teaching institutions would have to be established.

This reasoning led to the evolution of a well-phased plan covering the training of more and more scientists and engineers over the ensuing twenty-five years, at the end of which China would be turning out considerably more scientists and engineers than is now the case in the Soviet Union. This beautifully phased programme took as its starting-point the number of students currently attending the secondary schools. Provision was then made for the following: the establishment of more secondary schools; the direction of an increasing proportion of students to the study of science or engineering at institutions of higher learning; and the assignment of an increasing proportion of the graduates of these institutions to teaching-posts until a sufficient number of universities and engineering schools had been established.

While it is typical of the patient Chinese to take this long view, it is equally typical of Communist methods that continued exhortations should be made to take each step of the long road in the shortest possible time. Speaking last June, Chang Chin-fu, the Deputy President of the Chinese Academy of Sciences, made this statement: "We must make a continued big leap forward with the participation of the whole people. Basic changes in our scientific work have taken place in the last eleven years. Scientific research has developed into a mass movement, unprecedented in history, for the popularisation of scientific and technical knowledge."

FAR EAST IGNORED TOO LONG

One of the chief reasons for Western complacency about scientific developments in China has been the paucity of information about what has been happening in that country. One of the few Western scientists to have visited

FIG. 1 (*above, left*). The educational centre at Peking. By far the largest in China, it includes four universities with more than 10,000 students at each, and a number of research institutes. (*Camera Press*)

(*Hsinhua News Agency*)
FIG. 2 (*above*). Third-year oceanology students carrying out field work.

FIG. 3 (*below*). A lecture on atomic particle reactions at one of the Shanghai universities. (*Hsinhua News Agency*)

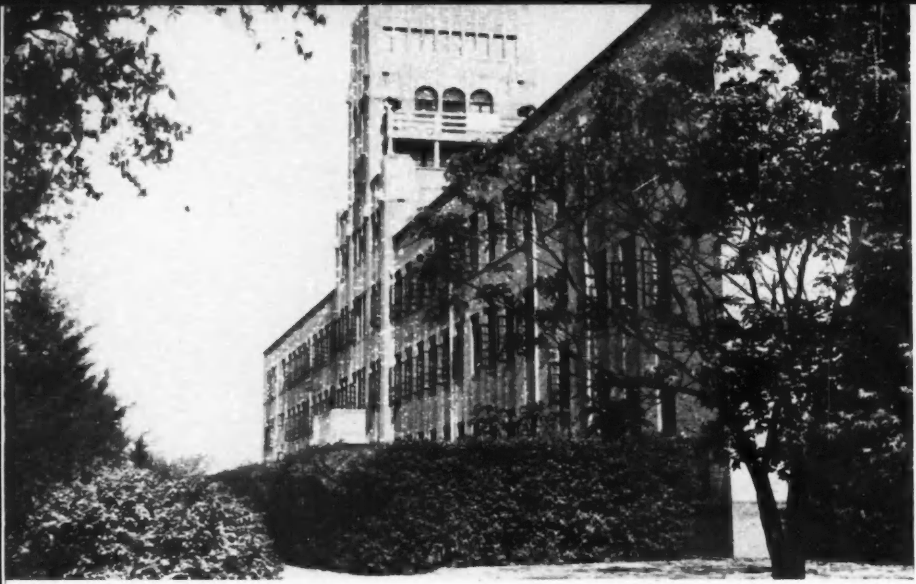


FIG. 4. A lecture hall of the North-west Agricultural College.

FIG. 5. Prof. Niu Lien-hsing (*wearing glasses*) explains the cultivation of new seed strains of wheat to students at the College.

Communist China in recent years is Dr J. Tuzo Wilson, Professor of Geophysics at the University of Toronto and President of the International Union of Geodesy and Geophysics. He accepted an invitation of the Academia Sinica to be their guest and spent three weeks in China in the late summer of 1958. He inspected a number of research institutes and institutions of higher education. He has published his impressions in a book entitled "One Chinese Moon", his visit having coincided with the waxing and waning of a new moon. Generally speaking, Dr Wilson was impressed with what he saw, particularly with the organisation and equipment of research laboratories and scientific libraries.

There is evidence that steps are soon to be taken to make amends for the lack of detailed knowledge about scientific developments in China. Next December a symposium on science in Communist China is being held under the auspices of the American Association for the Advancement of Science. The National Science Foundation of the United States is helping out with a grant of $30,000. This symposium will be similar to one held in 1951 on Soviet science.

When the Communists seized control of the whole of mainland China in 1949, there were two organisations for the promotion of scientific research. These were the Central Academy of Sciences at Nanking and the National Academy of Sciences at Peking. These, however, were poorly organised and lacking in adequate finance and equipment. They were responsible for overseeing the activities of seventeen research institutes. The Communists combined the two academies to form the Chinese Academy of Sciences, or Academia Sinica, with headquarters in Peking. This they proceeded to organise on the lines of the

FIG. 7. Students at the China Medical College watch an instructor carry out the classical conditioned-reflex experiment of Pavlov.

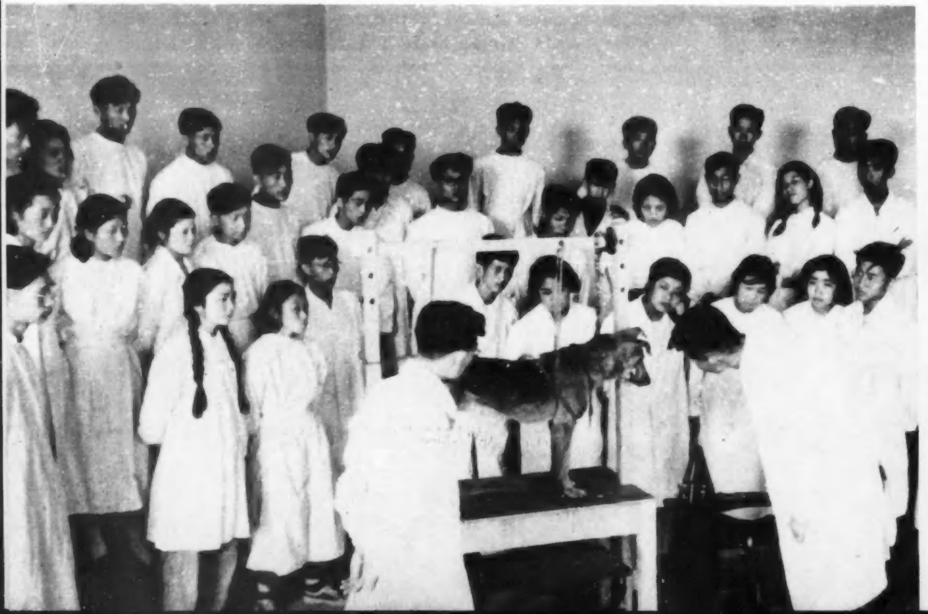


FIG. 8. Second-year students in bio-chemistry laboratory.

FIG. 6. Students in a pathology laboratory.

Soviet Academy of Sciences. The Academy in 1955 was divided into four departments, as follows:

Mathematics, Physics, and Chemistry, with ten research institutes.

Biology, Geology, and Geography, with twenty-four research institutes.

Technical Sciences, with twelve research institutes.

Philosophy and the Social Sciences, with ten research institutes.

New research institutes are constantly being added, so that the numbers indicated above for the year 1955 are now likely to have been exceeded.

It will be noted that the Chinese use the word "science" in the broad German sense, embracing the social sciences, and not in the more restricted English sense, confining it to the natural sciences.

BASIC RESEARCH FOR FUTURE GROWTH

The main function of the Academy is the organisation and promotion of fundamental or pure research. There is no tendency in China, as in some of the smaller Communist countries, to leave fundamental research to the wealthier countries and to concentrate on applying the results of the research to the national needs. On the contrary, the importance of fundamental research is constantly being stressed. Chang Chin-fu, the Deputy President of the Academy, had this to say on the subject last June: "Steps must be taken to strengthen research on fundamental theories. . . . Once all related production problems are thoroughly comprehended from the theoretical standpoint through research, it will become possible to improve and develop all creations and inventions and to popularise their application to a further extent. In carrying out construction

FIG. 9. Lecturers at a number of the colleges are translating Soviet text-books into Chinese.

(Photos on both pages from Camera Press)

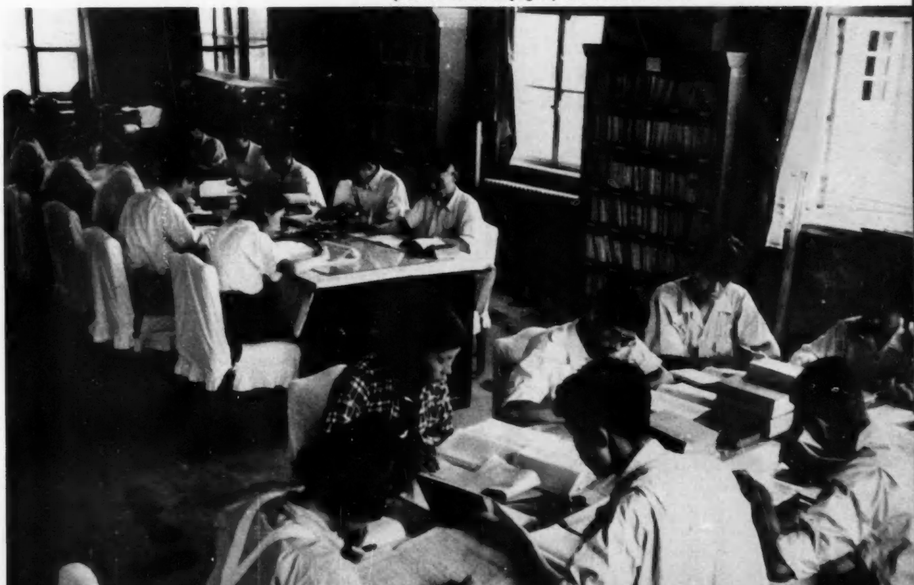
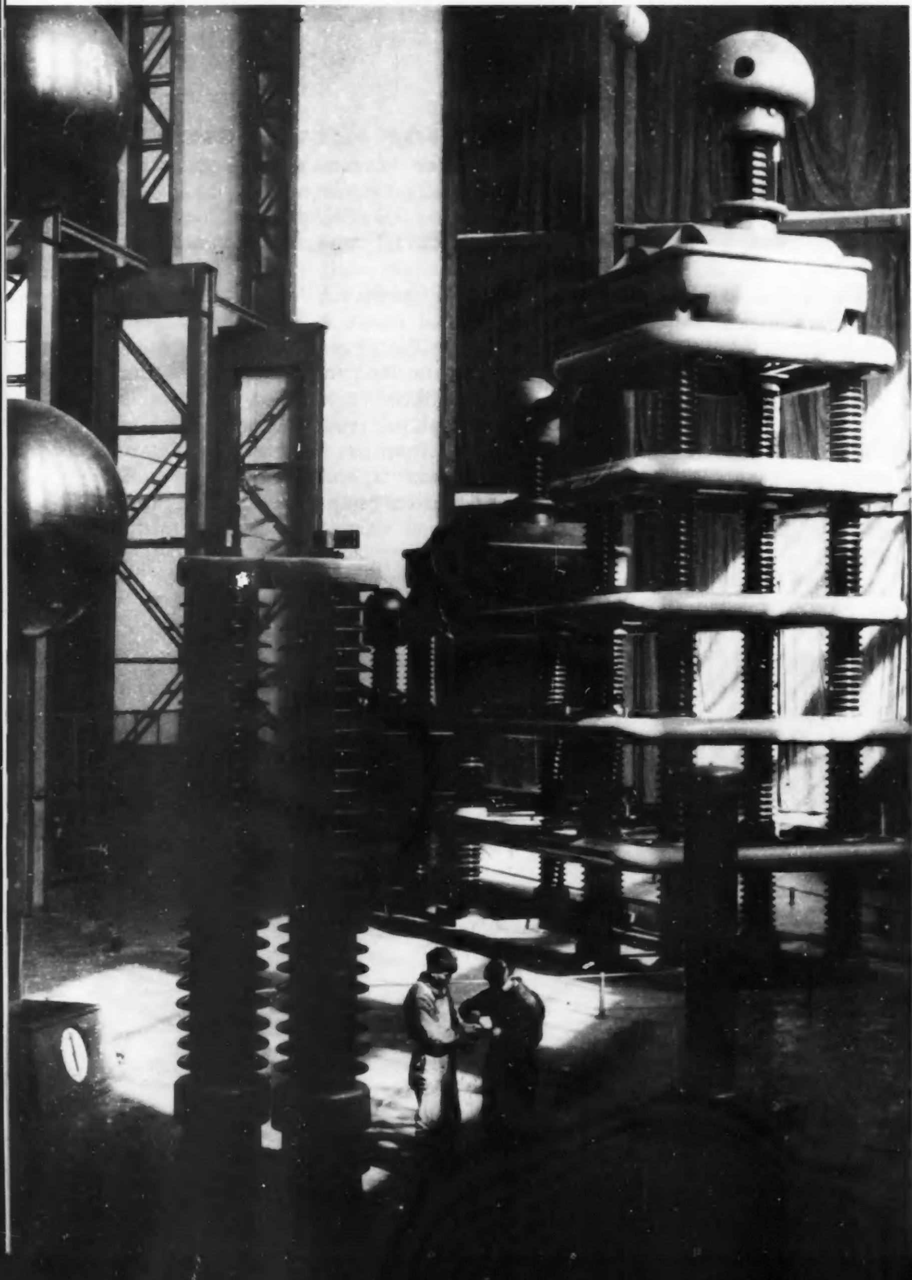


FIG. 10. Students of the South-China Engineering College performing laboratory experiments on magnetism.

in our country it will be difficult to rely solely on the world's established theories to solve our numerous special scientific and technological problems. We must rely on our own theories and creations. Efforts must be made to carry out as soon as possible research on the many theories in various scientific fields which may not at the moment play a prominent role in production but which may be expected to multiply man's productive force one hundred to one thousand times in the future."

In this statement there is a clear indication that the Chinese realise the degree to which research, along with investment, is a factor in economic growth, even though its results are much more intangible and difficult to estimate than those derived from investment.

Applied research is left to institutes connected with the industrial ministries, which divide up among themselves



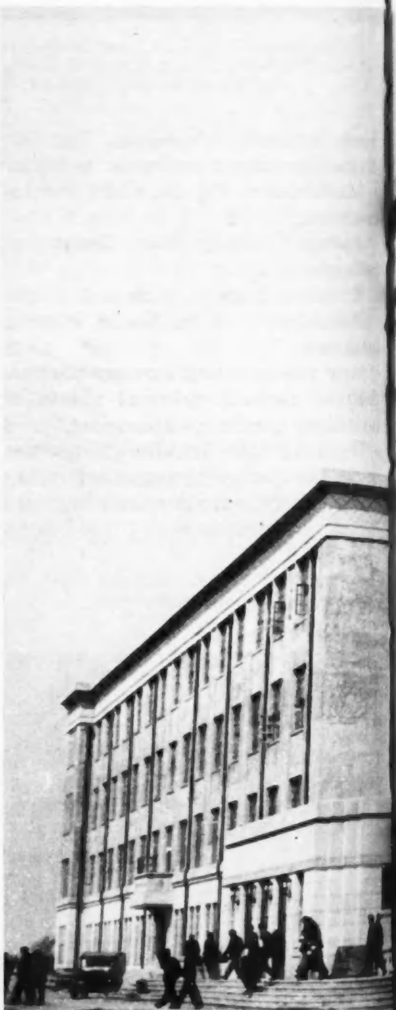
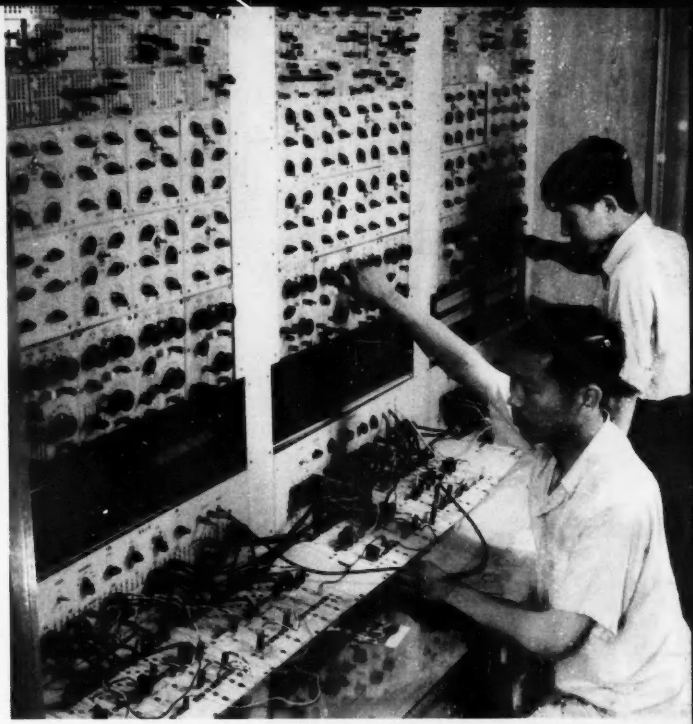


FIG. 11 (*left*). A high-voltage experimental unit in North-east China.

the responsibility of supervising the various industries in the country. When Dr Wilson was in Peking he inspected the Institute of Geology under the Academia Sinica and found out there was another institute with the same name under the Ministry of Geology. He also inspected the Institute of Geophysics and Meteorology of the Academia Sinica and later the Institute of Geological Prospecting under the Ministry of Geology. The latter was also a teaching institute with over 6000 students taking a five-year course leading to a degree.

THE ROLE OF THE SOVIET UNION

During the first half of the fifties the Chinese Academy of Sciences relied heavily on Soviet assistance and advice. In 1950 a delegation of Chinese scientists visited Moscow. Five years later a group of forty-two specialists in physics and mathematics, and in geology and geography, visited the Soviet Union and inspected some 150 scientific and research institutions in Moscow, Leningrad, Kiev, and Novosibirsk. They attended sessions of the governing body of the Soviet Academy of Sciences. The first formal agreement concerning scientific and technical co-operation was signed in Peking on October 12, 1954. This provided for the exchange of documents and information between the two countries and for the mutual exchange of visits of scientists. This was followed up by an agreement signed on December 11, 1957, between the two academies for collaboration and mutual assistance during the ensuing five years. In April 1955 a delegation from the Presidium of the Soviet Academy of Sciences came to China and stayed for two months. A few years ago, approximately 9000 out of the 10,000 Chinese students studying abroad were at institutions of higher learning in the Soviet Union.



(*Photos on both pages from Camera Press*)

FIG. 13. The computer above was one of the teacher-student projects at Tsinghua University.

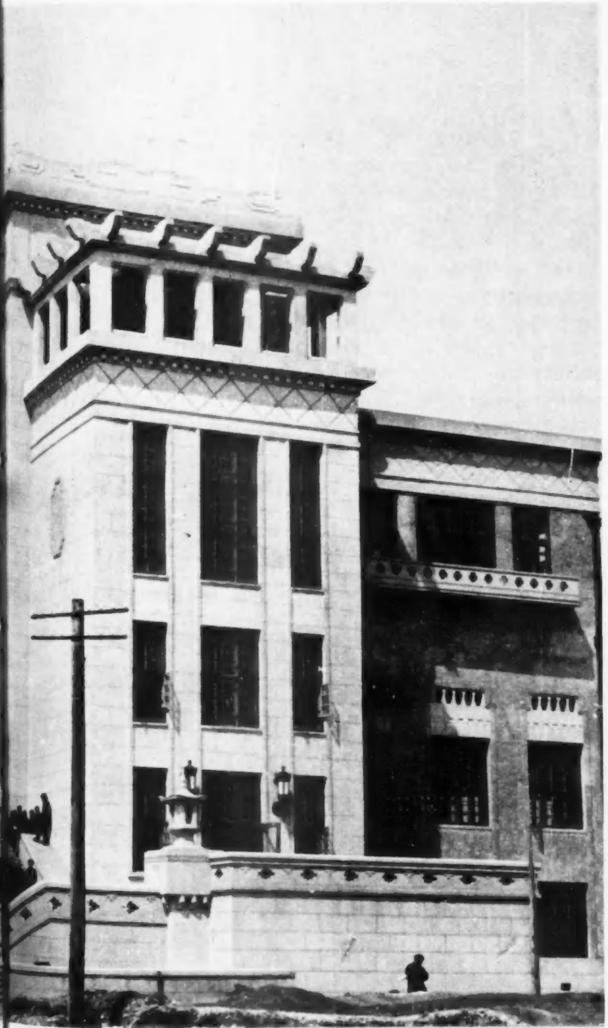


FIG. 12 (*above*). The North-east Engineering College in Shenyang (Mukden), one of the largest engineering schools in the country.

Lately there have been signs that the Chinese have become more independent of Soviet support. While collaboration between the academies of the two countries remains close, the Chinese are better able to stand on their own feet. Dr Wilson was surprised to find less Soviet influence than he had expected. At first, science courses at the universities were organised on the Soviet pattern of four years with thirty-five hours per week. This has been found too hard on the students and now many courses are being extended to five years with less hours per week. This is in accord with the German pattern of science education.

1960 GOAL: 280,000 NEW STUDENTS

It is in the field of education that the greatest efforts are being exerted at the present time. This is recognised as the key to the solution of the acute shortage of trained

(*Camera Press*)

FIG. 14. Kuo Mo-jo (*left*), President of the Chinese Academy of Sciences, with A. N. Nesniyanov (*right*), President of the Soviet Academy of Sciences during an official visit to the Soviet Union in November 1957. One month later there was a five-year agreement for collaboration and mutual assistance.

FIG. 15. When Kuo Mo-jo (*secon from left*) was asked to stand next t Mao Tse-tung for the photographe during the visit, his position symbol- ised the priority being given to scienc

scientists and engineers. Peking Radio recently carried this announcement: "The Ministry of Education announced on the 3rd of June, 1960, the details of new regulations for the enrolment of students during 1960. In order to cope with the needs of the leaping progress in industry, agriculture, and construction, the institutions of higher education have planned to enrol a total of 280,000 new students this year—30,000 more than in 1959. Most of this increase will be in engineering and the sciences. Under the leadership of local Party committees and people's councils, the local education agencies will adopt every means to expand the enrolment of students. It is necessary to rely on the leadership of Party committees at all levels and the implementation of the class line in order to ensure the fulfilment of enrolment assignments quantitatively and qualitatively."

By 1958 the total number of students at the institutions of higher education had reached 480,000. This compares with 155,000 students in 1947. The target set for 1962 is 850,000.

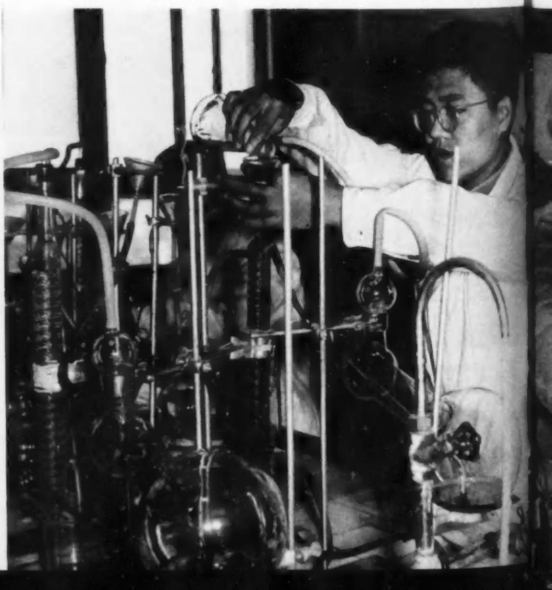
There were in 1957 about 227 institutions of higher education, including fifteen universities and forty-eight institutes of technology. Most of the universities in China are former foundations of the missionary societies. The University of Peking is the well-known missionary Yenching University. Peking is by far the largest educational centre in the country. There are four universities there, each with over 10,000 students. This includes the Tsing Hua University, one of the leading engineering colleges. Shanghai is another important educational centre. The tendency now is to spread the new colleges throughout the

FIG. 17. Li Feng-ying (*pointing*), an engineering student at the Kweichow Technological Institute who formerly worked in a printing house. Tens of thousands of workers like her are being redirected into science and technology.

(*Hsinhua News Agency*)

FIG. 18. Fourth-year student carrying out chemical analysis.

(*Camera Press*)



(*Camera Press*)

in China. To the right of white-haired K. E. Voroshilov, who was President of the Soviet Presidium at the time, is Soong Ching Ling, widow of Sun Yat-sen and sister of Mme Chiang Kai-shek.

(*Camera Press*)

FIG. 16. Three of China's leading scientists. Lo Tsung-lo (*left*) is chief of the Botanic Physiology Institute of the Academy of Sciences; Yin Hung-chang (*centre*) is the deputy-director. Chien Hsueh-sen (*right*) returned to China from the U.S.A. in 1955 to head the Dynamics Institute of the Academy.

country in order to lessen the concentration of higher education in Peking and Shanghai.

Efforts are continuing to stamp out illiteracy in China. This is a formidable task in view of the immense population and the general poverty of the people, but it is claimed that more than 70% of school-age children are attending primary schools.

A sizeable effort—probably the greatest single effort in Chinese education—is being made to increase the number of students finishing the senior secondary schools. Many more are needed for the expanding classes in science and technology at the universities and colleges. Dr Wilson encountered complaints about the insufficient supply of suitable students from the secondary schools wherever he went. He found in Sian that the number of secondary schools had been increased from four to twelve, and six more were planned.

A WARNING TO THE WEST

China has a population of 650 million or one quarter of the world's total. This is increasing at the rate of 17 million a year. By 1980 the total population of China will be approaching 1000 million. They will then be turning out more new scientists and technologists each year than any other country. A large manufacturing industry will have been created and the extensive natural resources of the country effectively exploited. By that time, China will have become a very great economic power. This is the significance of that nation's advance in science. It bears watching because it will be a key to "the shape of things to come".

FIG. 19. Once trained, students are rapidly put to work. Here a scientific worker from the Botanic Physiology Institute of the Academy of Sciences shows two members of the Chengtung commune how to prepare soil specimens for analysis as a step towards increasing productivity.

(*Camera Press*)

FIG. 20. One of the new generation of teachers standing over student doing analytical work on spectrograph at Wuhan University in Central China.

(*Hsinhua News Agency*)

A MASS APPROACH TO EDUCATION

FIGS 21–22. A campaign for the adoption of the new alphabetic script is under way everywhere. *Below*, workers at the Shihchingshan Steel Plant near Peking are given lessons during their off-hours. *At left*, woman described as a "worker-propagandist" writes "Everyone must learn the new annotating alphabet of Chinese language" on a blackboard newspaper at the plant.

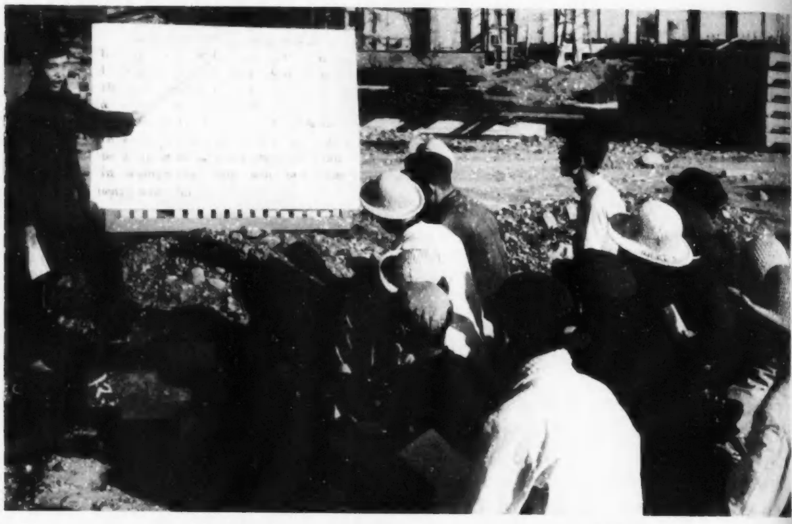


FIG. 23. Part-time classes are also held in the rural areas. After learning how to read and write, workers are sent to "junior classes" like that (*above, centre*) being held for the Shuanglung Production Brigade of the Heteh People's Commune in Hsiehyang County, Kiangsu Province.

FIG. 24. The Peking "television university"—set up for functionaries, teachers, army officers, technicians, and workers—is said to have a total enrolment of over 6000. Attending the television class above are teachers of the spare-time school at the No. 1 Hospital that is attached to the Peking Medical College.

(*Photos from Hsinhua News Agency*)

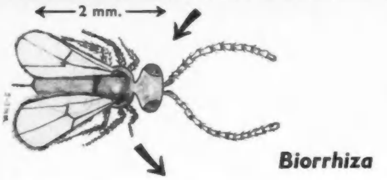
FIG. 25 (*above*). When the Executive Council of the World Federation of Scientific Workers met in Peking, a banquet was given in their honour by China's Premier, Chou En-lai, shown proposing a toast. Seated at his left was a leading Soviet Academician, A. I. Oparin.

AN UNPRECEDENTED RECEPTIVITY TO SCIENCE

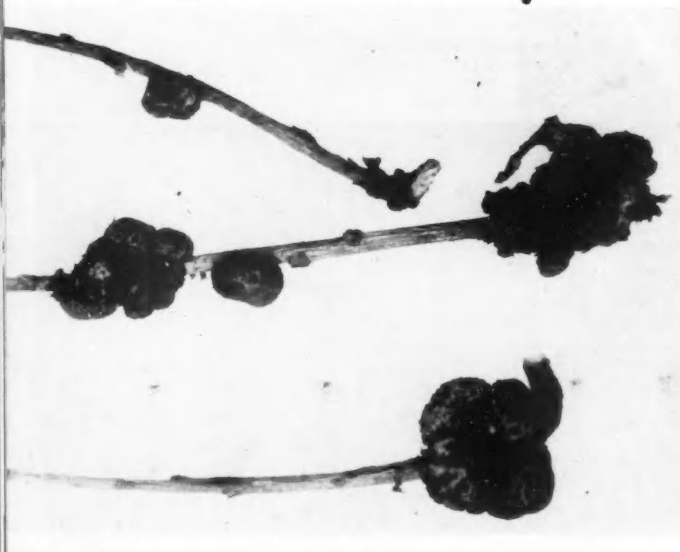
FIG. 26 (*below*). Mass meetings are held regularly. On December 12, 1956, one was held in Peking to commemorate the achievements of Benjamin Franklin and Pierre and Mme Curie. Shown speaking is the French nuclear physicist Dr Helene Langevin, granddaughter of the Curies. Selection of Benjamin Franklin, American Revolutionary Period statesman-scientist, was surprising in view of anti-American feeling engendered by Korean conflict and steadfast refusal of U.S.A. to recognise the *de facto* government.

(Photos from Camera Press)

Oak Apple



Biorrhiza



Oak Marbles

THE STRANGE WORLD OF THE VEGETABLE GALL INSECTS

P. J. ALEXANDER

These odd insects disregard the orthodox ideas about reproduction. Some do not reproduce similar offspring directly but alternate between totally different forms. In several species, the females produce male or female offspring without mating, but never both.

If we define vegetable galls as abnormal excrescences in plants, this would include those induced artificially, those caused by chemical action, and those due to wounds or fungi. This article deals with those caused by the deposition of eggs by "insects" (in the wide sense) in parts of the plants.

Vegetable galls have apparently been known from the early days of history since specimens have been observed on fossilised plants. But the study of galls was not taken up seriously until the latter part of the 19th century when scientists all over Europe became interested in them. Since then, great progress has been made. Whereas the number of known species in 1859 was only 350, we are now acquainted with some 6000, thanks to the work of men like Dr Alfred Nepala of Austria, Focheu of France, von Schlechtendal of Germany, Cecconi of Italy, Trail of Scotland, Fitch in England, and Trotter in Spain and Portugal, to mention only a few of the more prominent workers. In the present century the late Dr Barnes of Rothamsted Experimental Station made gall midges his life study. Several new species have been described and named by him, and a vast output of literature on the subject has appeared under his name in numerous learned journals over the past thirty years.

The animal agents responsible for these growths include 1400 insects and arachnids, 113 species of beetle, chiefly weevils, 240 species of gall wasps (four-winged hymenoptera), 486 diptera or true gall flies, 50 lepidoptera, 233 hemiptera, and 263 acarids.

Over 2000 species of plants (including monocotyledons, dicotyledons, gymnosperms, and cryptogams) are known to be infected by galls, 800 of which occur among 78 different species of oak. Eggs are laid in any part of the plant: flowers, catkins, buds, leaves, stem, bark, and root. Many plants attacked in this way are of considerable commercial value—cooking herbs, medicinal herbs, fibres, textiles, cacao, coffee, tea, hops, grapes, rubbers, oil plants, spices, and dye plants.

LIFE-CYCLE

The eggs are laid in the soft meristematic tissue in leaves and buds and in the cambial layer in twigs, branches, and

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roots, for this is where cell growth normally takes place.

It is not the egg-laying "insect" which makes the gall, but the resulting larva which, by producing an irritant liquid, causes the special shape of gall peculiar to that insect. In the case of the saw-fly, however, it is the egg which is the irritant.

Of particular interest is the life-cycle of the insect responsible for the **Oak Apple**. This is a wingless female insect which has emerged from a root gall (made by *Biorrhiza aptera*, Bosc.). In early spring it climbs up the tree and lays unfertilised eggs in the twigs high up, especially in terminal buds. The resulting larvae produce a soft, roughly round, spongy growth that is brownish at first, and then becomes streaked with red. It is 25–50 mm. in diameter, and contains a large number of larvae which turn into male or female "flies", *Teras terminalis*. The latter, in their turn, after mating, lay fertilised eggs in the roots and produce the root gall, *Biorrhiza*. This gall "fly", *Teras* (more correctly gall wasp, as it has two pairs of wings), is about 2–3 mm. long, the wings, when closed, extending well beyond the body. Its thorax and abdomen are ant-like in shape and its head is surmounted by antennae consisting of twelve or more conically truncated segments covered with short stiff hairs.

Here we have an excellent example of what is known as alternation of generations, involving parthenogenesis or virgin birth. Here, too, is a striking case which upsets the famous dictum that "like begets like", for a wingless, unmated insect coming from a hard root gall lays her eggs on twigs high up the tree, producing soft spongy galls from which emerge four-winged gall wasps, either male or female. The latter return to the roots for egg-laying, causing the single or conglomerate galls of *Biorrhiza aptera*, which once again produce the wingless female and so complete the cycle.

This spongy gall is the real Oak Apple, formerly worn on Royal Oak Day (May 29) to commemorate the escape of Charles II by hiding in an oak tree.

These Oak Apples, if not eaten by squirrels, pecked by birds, or devoured by other insects, present a dried-up and honey-combed appearance in autumn and winter. What so many people mistakenly call Oak Apples are nothing more than **Oak Marbles.** These are hard and smoothly round, green at first, becoming brown. They contain one main centrally situated grub of *Cynips Kollari*, and generally also support a number of parasites. They may remain on the twigs throughout the year. Some of these larvae winter in the gall and others, less resistant to weather conditions, fall with the leaves and hibernate in the soil.

Egg laying by *Biorrhiza aptera* is quite an exhausting process. One female has been known to take over a week, non-stop, in disposing of 580 eggs. They must be inserted deep down between the scales of the bud and the ovipositor must be withdrawn and re-inserted for each egg.

THE CHROMOSOME PROBLEM

Alternation of generations usually implies that a normal bisexual generation is followed by a unisexual one. Thus the male and female imagines of *Teras terminalis*, Fabr., produce a female gall insect (we cannot strictly call it fly


Currant Gall


Silk Button Gall


Woolly or Cotton Gall

Artichoke Gall

Spotted Bud Gall

Oak Spangle Gall

or wasp as it has no wings) from a root gall, *Biorrhiza aptera,* Bosc. This insect, without any male co-operation, produces either male or female gall wasps (but not both) in the Oak Apple.

Now, in normal reproduction, the nucleus of the egg cell receives half its chromosomes from one parent and half from the other. The inquiring mind will then ask: What happens to the number of chromosomes in asexual reproduction or parthenogenesis? The matter is rather complicated but, in a simple generalised form, what takes place is as follows. The unmated female lays only one kind of egg, producing either males or females. Eggs destined to produce males will have only half the normal number of chromosomes (haploid) as meiosis or reduction division will have taken place; those destined to produce females will have the full number of chromosomes (diploid), reduction division in maturing cells having been omitted. If and when the female reverts to producing fertilised eggs, she must then also resume meiosis (halving the number of chromosomes) in the maturation division.

SOME NOTABLE SPECIES

The Currant Gall is one of the best known of the oak galls. It may be found especially on the catkins and the leaves, and, in years when it is plentiful, on the young twigs. It is about the size and shape of a small pea. Those that grow on the under surface of leaves are somewhat larger than the others and usually retain the colour of a small white grape but those growing on the catkins become tinged and streaked with red and even purple, finally shrivelling up when the fly has emerged. They consist of a very soft, juicy tissue and are much in evidence during May and June.

The Silk Button Gall is a pretty little growth, measuring 2–3 mm. in diameter by 1–2 mm. thick. It looks brown because it has a covering of minute silky, fawn-coloured hairs; if these are rubbed off, the outer skin of the gall will be found to be crimson-lake and will have a papillate appearance. The edges are beautifully rounded and in the centre there is a very well marked depression. Under this and near the point of connexion with the leaf is the hollow cell of the grub, *Neuroterus numismatis.*

These galls may be found in dense clusters on the under surface of the leaves of *Quercus pedunculata* and are very common in August and September. In October they begin to fall.

The Woolly or Cotton Gall is by no means common and only those who scan very carefully the young catkins of the oak in early May can hope to find it. It makes a very brief appearance of about a week, and may be situated high on the tree and out of reach.

It looks like a mass of cotton wool, whitish or slightly yellow. This appearance, however, is due to a covering of white hairs about half an inch long. If these be removed, the real gall will be found adhering to the axil of the catkin. It is brown and oval and generally several are found united together.

The Artichoke Gall, *Andricus fecundator,* Hartig., so appropriately named because its appearance is not unlike that of the artichoke with its large imbricating outer leaves.

The gall is found more frequently on dwarfed oaks than on tall trees. The enlarged bud scales overlap and enclose a central cavity containing a small hard rounded cylindrical gall enclosed by several rows of stiff bristle-like scale leaves, fringed with silk hairs. It is a long time coming to maturity and the imago sometimes does not emerge for 2½ years. It is preyed upon by no less than eight parasites and it may also harbour some inquilines—grubs that feed on the gall substance but do not harm the larva. The alternate generation occurs in *Andricus pilosus*, Adler, a very small hairy gall on the staminate catkins of *Q. pedunculata*.

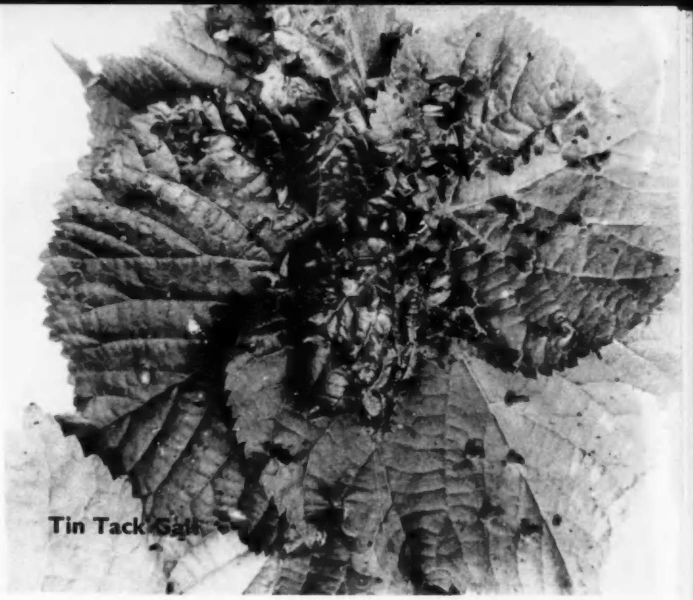
The Spotted Bud Gall, *Andricus albopunctatus*, Schl., may be found in May and June. It is glossy, furrowed lengthwise, its rounded top coming to a point. The outside walls are blotched with cream-coloured patches. The larval chamber is thick but not hard enough to keep out a number of parasites. It has no alternate generation.

The Oak Spangle Gall, *Neuroterus lenticularis*, Oliv., appears to be totally different from the Currant Gall, but is actually made by alternate generations of the same fly. These spangles are about 5 mm. in diameter and somewhat broadly conical. They are attached to the lower surface of the leaf by a short stem. The side nearest the leaf is whitish and smooth, whereas the lower surface is yellow with abundant clusters of stellate hairs. The galls are very numerous and nearly cover the leaf. They are unilocular, but support several parasites and inquilines.

The Tin Tack Gall of lime is well named, as it looks very like small sharply pointed nails sticking out abundantly from the upper surface of the leaf. Their red colour is in marked contrast with the tender green of the foliage. These galls are 6–10 mm. long and hollow. They have an opening on the under surface of the leaf, but this is closed by a thick growth of hairs. The insect cause is *Eriophyes tiliae*, Pagaust. Sycamore leaves covered with hundreds of **Red Pimple Galls** are a familiar sight and, like the previous species, are hollow, filled with cylindrical hairs and open on the under surface, the agent in this case being *Eriophyes macrorrhyncus*, Nal.

Robins Pincushion, sometimes known as the Sponge of the Passion, can be found on many of the varieties of rose. It measures 25–50 mm. across and outwardly is covered with long sticky branch-like bristles, at first light green in colour, then becoming tinged with red. Also known as the Bedeguar Gall, it occurs on leaves, buds and twigs and may contain upwards of fifty cells, hard and woody, and welded together. It feels like a moss rose to touch; the stickiness is caused by honeydew. This gall is the work of *Rhodites rosae*, L.

Among the conifers, probably the best-known gall is that caused by *Adalges abietis*, Kalt., on spruce. It is very like a year-old cone to look at and has been appropriately named the **Pineapple Gall**. It is 1¼ in. long and grows attached to one side only of a twig which bends round it with the gall on the concave surface. Punctures made in the tender green needles by the queen aphis on emerging from hibernation cause the needles to swell and fuse at their bases, leaving between them cavities that are later filled with fine hairs and larvae. The gall is blotched with patches of colour, sometimes white but more often red-brown. The author of


Tin Tack Gall


Robins Pincushion


Pineapple Gall

Spiked Pea Gall

Ground Ivy Gall

Horse Bean Gall

this growth is a small, wingless insect of a dirty green colour which, after the long, foodless winter months, soon fattens up on the sap of the young green leaves.

The familiar Dog Rose of our country hedges provides us with another pretty little gall called the **Spiked Pea Gall**. It is slightly smaller than a pea and has long fine pointed spikes on the outside. It usually grows on the under surface of the midrib and is quite inconspicuous at first, when it is pale green. It later becomes tinged with red and finally turns brown. Common from July to October, it is best found by bending down and looking upwards, for it shows up against the leaf. The imago *Rhodites rosarum*, Giraud., comes out in the following spring.

The Ground Ivy Gall is a common sight on sunny banks or borders of woods in June and July. With a diameter up to half an inch, several galls fuse together on both stem and leaf. They are thickly covered, like the stem of the plant, with short white hairs. The gall, at first green, becomes tinged with red later on. They may be easily kept throughout the winter. The "fly", *Aulax Glechomae*, L., appears the following May.

Five hundred different galls are known to affect the Willow family. Let us take as our example the **Horse Bean Gall**, one of the most conspicuous. Found extensively on the leaves of the Crack Willow in almost any position except on the midrib, it is green at first, then becomes red or even purple on the side exposed to the sun. It may be up to 26 mm. long by 8 mm. broad, and unlike most other galls, protrudes equally from either surface of the leaf. Caused by the gall wasp *Nematus gallicola*, it is especially noticeable in July, but may be found any time between May and October.

EFFECTS

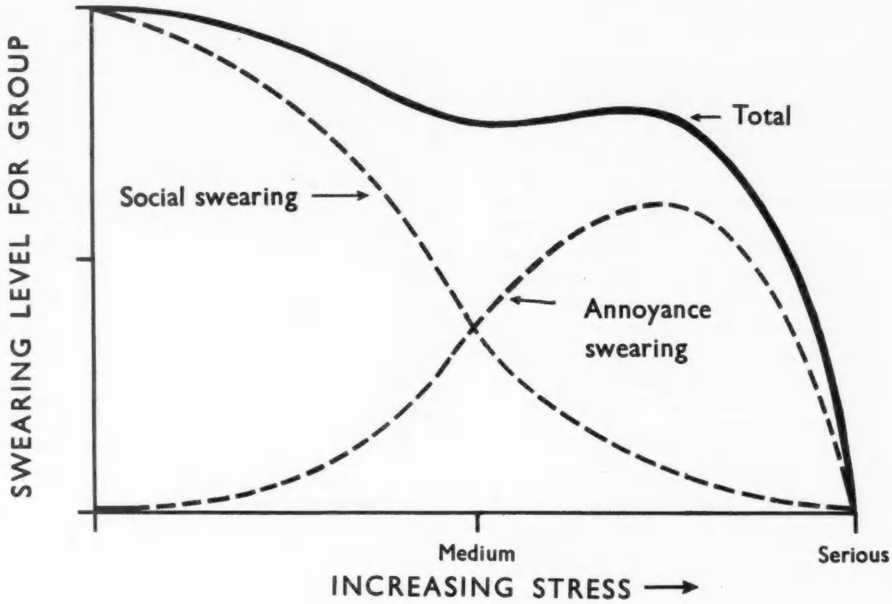
The great majority of vegetable galls do no harm to the plant they infect, apart from causing an unsightly distortion of tissues, although the Hessian Fly, now generally under control, can destroy large areas of wheat. Midges and mites are harmful to fruit trees and Phylloxera to vineyards. Some gall midges are predatory on aphids; others feed on the eggs of the red spider of tomato houses. Some predaceous larvae attach themselves to the ventral surface of mealy bugs and thus destroy this pest of pear and apple trees, pineapple, and citrus fruits. The number of gall-making organisms is kept down by the work of small parasites which feed on the larvae; others are destroyed by birds searching for grubs—woodpeckers, tits, tree creepers, and so forth. Those sticky with honeydew are appreciated by field mice.

A number of galls are actually useful. The astringent properties of some make them useful in medicine. Bees take a surprising weight of honeydew from others. An industrially valuable output of tannic acid and writing-ink is derived from Cynips, and other galls provide food for poultry and cattle.

The many galls still unidentified offer the enthusiast plenty of scope for research. It is an agreeable and entertaining hobby. The rearing of the agents from eggs or larvae is usually simple and the imagines can be easily collected and studied at leisure.

PATTERNS OF SWEARING

HELEN E. ROSS



Observations made on a group of scientists during an expedition to Arctic Norway showed two types of swearing, each a function of stress. Under conditions of heavy stress, swearing ceased completely.

Swearing is a subject which seems to have received very little attention from psychologists. It is seldom mentioned, except in the course of some other study, and only the psycho-analysts offer theories about its origin and purpose. Fenichel,[1] for example, regards obscene swearing as a substitute sex activity which gives the swearer a sense of power over the sex demon. This theory may help to explain obscene swearing, but does not account for the blasphemous swearing which often occurs in the same breath. Moreover, for many people, especially among the industrial working classes, swearing is a habit which has no more meaning than a difference in dialect.

Upbringing and temperament clearly play a large part in determining the swearing habits of an individual, but I was especially interested in the way group morale can encourage or discourage swearing in its members.

Helen E. Ross, B.A., a schoolteacher, is now studying educational psychology and doing research on achievement motivation of children.

Since swearing is often thought to be a sign of annoyance or stress, I kept records of swearing rates as an indication of group morale during three weeks of a university expedition to Arctic Norway. The group consisted of five men and three women between nineteen and twenty-four years of age, all of whom were zoologists, except myself, a psychologist.

The main purpose of the expedition was to study the diurnal rhythms of birds during continuous daylight. As the work entailed considerable interruption or loss of sleep, most members had good cause for becoming irritable and swearing.

I recorded the swearing rates for each member on different coloured knitting counters which I kept in my pocket. Records were only kept for a few hours at the beginning and end of each day when most of the group were together, but these scores were sufficient to show general trends. Unfortunately, the group soon discovered I was keeping records, but after the initial reactions of anger or amusement had died down this seemed to have

no effect on the scores (apart from one day when the two heaviest swearers engaged in a deliberate competition).

Each individual had his own vocabulary and habitual level of swearing, and tended to keep to the same rank order in the group however much the total swearing-level rose or fell.

The words used were blasphemous rather than obscene, as is to be expected among the middle classes. Unlike the working classes, however, their use of obscene words was deliberate rather than habitual, and they took a delight in using them in their correct biological sense. The heavier swearers used the more violent language. No new expressions were coined apart from the word "Click!" which arose in connexion with my knitting counters. Hence such phrases as "That clicking psychologist!"

The relationship between swearing and stress was slightly unexpected. The amount of swearing increased noticeably when people were relaxed and happy and, though it also increased under slight stress, it decreased when they were really annoyed or tired. In fact there seemed to be two types of swearing: "social" swearing and "annoyance" swearing. Social swearing was intended to be friendly and a sign of being "one of the gang"; it depended upon an audience for its effect, while annoyance swearing was a reaction to stress regardless of the audience. Social swearing was by far the commoner.

The total amount of swearing varied as shown on p. 479. Under conditions of very low stress it was almost entirely

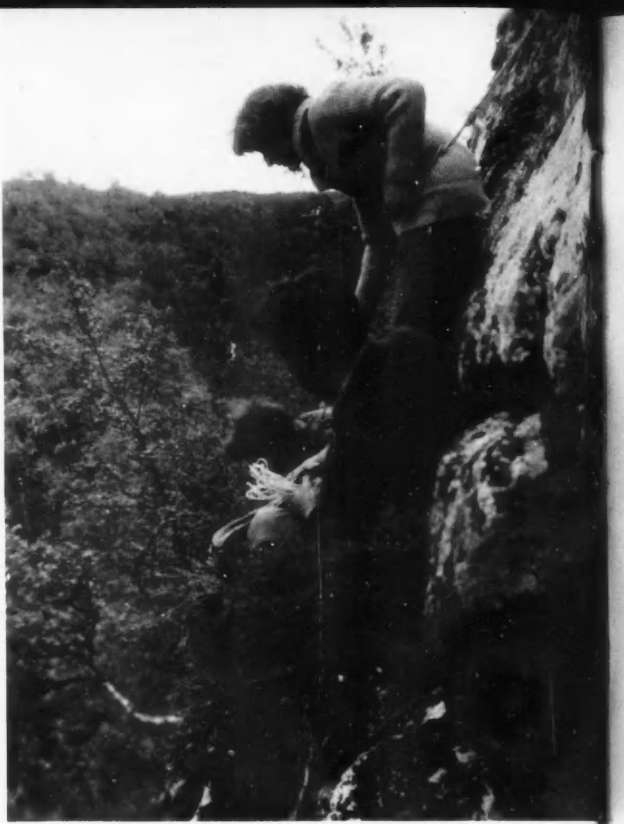


FIG. 2 (*above*). Three of the zoologists climbing down a cliff face in the cold rain at 4 a.m. to ring young rough-legged buzzards in their nest—a typical medium-stress situation that produced considerable "annoyance" swearing and a little "social" swearing.

FIG. 3. The camp site. Over-tiredness or wet weather increased the amount of "annoyance" swearing. Under extreme conditions, however, swearing dropped off to a minimum as the group lapsed into an anti-social silence.

the social type, but with increasing stress the amount of social swearing diminished and annoyance swearing increased. It was interesting to note that the drop-off of the one was more rapid than the rise of the other, resulting in a dip in the total under conditions of medium stress. Under higher stress, social swearing almost entirely disappeared and annoyance swearing increased until it too reached a peak and began to drop. Under conditions of serious stress, there was silence.

Social swearing was easily inhibited by the lack of an appreciative audience or the presence of non-swearers. The men who had been in camp for a week without the women said they felt it necessary to watch their tongues once the women arrived. When half the group, including the only three non-swearers, left on a separate expedition, the swearing rate immediately doubled and remained very high. This may have been due to a deliberate attempt to compensate for lost numbers by an increase in solidarity. Similarly, when a medium swearer (female) spent two days alone with a heavy swearer (male), the swearing rates of both increased, but when she spent a fortnight with a medium swearer (male), all swearing soon stopped, probably because the latter two needed the facilitative effect of a heavy swearer or a larger audience. Other subjects might not be so easily influenced by the moods of their companions, but unless they are affected to some degree their swearing cannot be classed as "social" and must be merely a verbal habit.

The fact that the usual reaction to serious stress is silence suggests that swearing is a sign that a disagreeable situation is bearable; indeed, the verbal expression of discomfort may even help to reduce stress. There is some experimental evidence which seems to lend support to the hypothesis that, in a given situation, subjects who swear or complain are likely to be under less stress than those who keep silent. For example, Reiser *et al.*,[2] when examining the effects of different laboratory procedures on the physiological reactions to stress of enlisted soldiers, found that those subjects who felt free to "gripe" about army life with their interviewer were much less likely to show a rise in blood pressure than those who did not complain. King and Henry[3] have shown that subjects who direct their anger against the experimenter when under stress show a less tense physiological reaction than those who control their anger (a nor-epinephrine cardiovascular pattern as opposed to epinephrine). A similar difference was found by MacKinnon[4] among subjects taking a written test where it was possible to cheat; those who swore and blamed the questions were liable to cheat without compunction whereas those who kept silent or blamed their own stupidity felt guilty at the very idea of cheating and were more anxious and tense during the test.

The scientific study of swearing is complicated by the difficulty of deciding what is to count as swearing. The same words may be habitual for one individual and very rare for another. In future studies it would probably be best to discount habitually heavy swearers and concentrate on medium swearers. More light might be thrown on social swearing by studying the same individual in similar experimental situations but among different sizes and types of groups. More direct experiments could also be made on the effects of swearing on reducing tension, and on the differences in upbringing and personality which encourage such swearing; using Eysenck's[5] extraversion-introversion scale I should expect heavy swearing to correlate with extraversion and light swearing with introversion.

REFERENCES

[1] Fenichel, O., 1946, "The Psychoanalytic Theory of Neurosis", p. 350, Routledge & Kegan Paul Ltd.

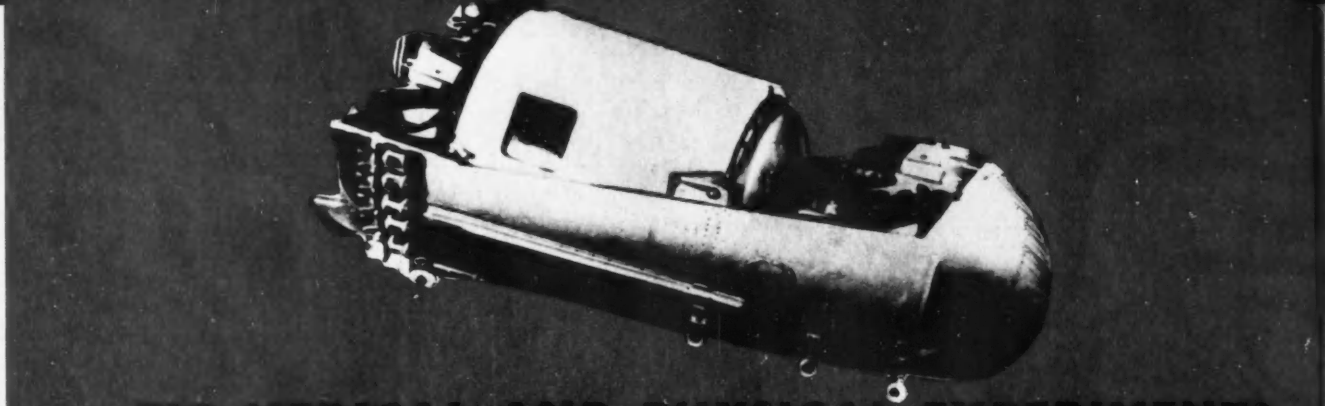
[2] Reiser, M. F., *et al.*, 1955, "Effects of Variation in Laboratory Procedure and Experimenter on Cardiac Data in Subjects", *Psychosomatic Medicine*, vol. 17, pp. 185–199.

[3] King, S. H., and Henry, A. F., 1955, "Aggression and Cardiovascular Reactions Related to Parental Control Over Behaviour", *J. Abnorm. Soc. Psychol.*, vol. 50, pp. 206–210.

[4] MacKinnon, D. W., 1937, "Violation of Prohibition", in H. A. Murray's "Exploration in Personality" (pp. 491–501), New York, O.U.P.

[5] Eysenck, H. J., 1947, "Dimensions of Personality", Kegan Paul.

FIG. 4. Members of the expedition on a twenty-mile all-night trek over rough tundra. The group started out at 7 p.m. in a sociable mood; there was little stress and the swearing was of the "social" type. By morning, fatigue, thirst, delays, and disagreements about the best route were resulting in a fair amount of "annoyance" swearing. Towards the end of the trip the group —exhausted and hungry—split up into twos and threes and straggled back to camp in silence.



BIO-MEDICAL AND PHYSICAL EXPERIMENTS IN THE SOVIET "ARKNIK"

Although the weight, orbital data, and pictures of the two canine passengers have been widely published, the scientific and technical details have received little attention outside the U.S.S.R. This report is based on information from official Russian sources.

The experiments carried out in the 10,000-pound satellite launched by the Soviet Union on August 19 indicate the seriousness and determination with which that country is preparing for manned space-travel. Inside the cabin, which was recovered after eighteen revolutions round the earth in a low orbit,* were (in addition to the two dogs, Belka and Strelka): twenty-one black and nineteen white test mice; several hundred *Drosophila* fruit flies; two vessels with *Tradescantia* plants; the seeds of different varieties of onions, peas, wheat, maize, and *Nigella*; special vessels with actinomycete fungi; and the unicellular alga *Chlorella* in liquid and solid nutritive media. Also, fifty cartridge cases containing sealed ampules of cultures of intestinal bacteria (type KK-12, B, "aerogenes"), butyric fermentation bacteria, a culture of staphylococci, two varieties of phages (T-2 and 13-21), desoxyribonucleic acid solution (DNA), a culture of human epithelial tumour cells (He-La cells), and small pieces of preserved human and rabbit skin. In addition, the container carried four automatic bio-elements with a culture of butyric fermentation bacteria, two enclosed in a special thermostat and two in an unheated container. Since this satellite launching was one of the preliminary steps in the Soviet manned space-flight programme, the bio-medical experiments were designed to provide data on:

Specific features of the vital activity of different animal and plant organisms during a space flight.

The biological action of space-flight conditions on living organisms (over-strain, prolonged weightlessness, the transition to and from weightlessness).

The action of cosmic rays on the vital activity and heredity of animal and plant organisms.

Systems for maintaining life and well-being during space flight (air regeneration, temperature regulation, food and water supply, sanitation, etc.).

TEST OF LIFE-SUPPORT SYSTEMS

The biological container used in this satellite was described as a "variant" of the one designed for manned flight; the specifications were very much like those that might be set down for a human passenger. The oxygen concentration of the air was to be maintained at 20% to 25% with a carbon-dioxide concentration no higher than 1%, the temperature was to be between 15° to 25°C, the relative humidity at 39% to 70%, and the pressure at one atmosphere. The air was to be cleansed of any harmful admixtures resulting from the activity of the animals and the operation of the equipment. (The two dogs normally consumed 8 to 9 litres of oxygen an hour; they exhaled 6 to 7 litres of carbon dioxide an hour, and ¼ litre of water per day.)

For this flight, and for future ones lasting up to fifteen or twenty days, the Soviet scientists concluded it would be best to regenerate the air in the cabin by using highly active chemical compounds that would absorb carbon dioxide and water vapour and emit the proper amount of oxygen. Since the rate of oxygen emission did not always correspond to the amount needed, a special control system was added. Special filters were used to prevent a harmful accumulation of toxic substances in the air. A liquid-air unit was used to maintain the prescribed temperature inside the cabin.

Although the animals would have been capable of withstanding wider variations in the environment than those specified, the Soviet scientists stated they wished to minimise the strain from extreme environmental conditions to leave a margin for the strain from high accelerations, weightlessness, etc.

The feeding and watering of the test animals under zero-gravity conditions presented a problem. Food that broke into pieces and uncontained liquids could easily float out of reach. The difficulties were overcome by using a glutinous jelly-like mixture that contained the proper amount of nutritious matter and water. This method of feeding was similar to that used with the dog Laika in *Sputnik II*. Calculation and experiment showed that the following mixture would supply the food and water requirements of a 7-kg. dog confined for a long period under the environmental conditions prescribed:

* Apogee, 360 km.; perigee, 339 km.; period, 90·7 mins; angle of orbital plane 64° 57′.

Product	Grammes	Proteins	Compound fat	Hydro-carbons	Calorific content in kilo-calories
1. Meat (below average fatness)	80	15·89	2·74	—	90·6
2. Compound fat	30	—	28·36	—	263·7
3. Rolled oats	10	0·91	0·6	6·1	34·3
4. Agar-agar	2	0·06	—	1·8	7·6
5. Water	188	—	—	—	—
6. Sausage	20	3·84	4·5	—	57·6
7. Vitamins C, P, A, B_1, B_2, PP, B_6	less than 1 g.				
Total:	331	20·7	36·2	7·9	453·8

Having a jelly-like consistency, this mixture clings to the walls of a dish and is not jarred loose when the dish is overturned under zero-gravity conditions. It can, furthermore, be prevented from spoiling by sterilising it in an autoclave at a temperature of 115°C. To feed the dogs during flight, the lid on the feeder was automatically opened at regular intervals. Tests on the ground showed that dogs kept on this mixture for a lengthy period did not lose weight or feel thirsty; use of the automatic feeder, however, called for prolonged and systematic training of the animals under simulated space-flight conditions. (The type or degree of simulation was not described.)

To feed the mice and rats, pipes containing dry briquetted food were placed alongside the cages. Water was conveyed from the supply tank to the cage through a pipe with a wick.

ANIMAL EXPERIMENTS

Dogs were used for the main biological experiments because their normal physiology has been well studied. They are easy to train and offer good resistance to various physical influences. In addition, methods have already been developed for recording their various physiological parameters. Mongrels were preferred because of their high resistance to external factors. Those selected for training were between eighteen months and three years old, small enough in size to ensure a sufficient freedom of action inside the capsule, and with sufficient colour to ensure high-quality pictures of their movements on the TV screen. Great importance was attached to their nervous activity. Dogs of a strong, steady, and agile type were chosen in which the conditioned reflexes needed for the experiment could easily be developed. They were subjected to a thorough physiological and clinical veterinary examination. In order to record their arterial blood pressure, an operation was performed to bring the carotid artery to the surface of the neck in a flap of skin. To obtain reliable records of the cardiac currents, electrodes were introduced under the skin. During the lengthy training period, each of the animals was tested in vibration and acceleration devices to be certain it would be able to withstand the conditions that would be met during the actual launching and recovery.

The dogs chosen for the August 19 flight, Strelka and Belka, were both females. Strelka, light-coloured with dark spots, weighed 5·5 kg., stood 32 cm. high, and measured 50 cm. from nose to tail. Belka, a light-coloured and short-haired dog, weighed 4·5 kg., was 30 cm. high, and measured 47 cm. from nose to tail. On being selected, both were kept on a pre-flight régime.

The physiological information recorded during the flight included arterial blood pressure, electrocardiograms, frequency of respiration, body temperature, and movements. Data transmitted to earth-stations by radio-telemetry (with a memory unit to store data when the satellite was out of range, for later transmission) included cabin temperature, pressure, humidity, and control data on the functioning of the life-support systems. In preparation for manned space flight, considerable attention was devoted to the study of the motor activity of the dogs, particularly the co-ordination of their voluntary movements. Television was used

FIG. 1 (*top, left*). The cabin section which was separated from the *Arknik* after re-entry into the atmosphere and recovered. The rest of the satellite was allowed to burn up.

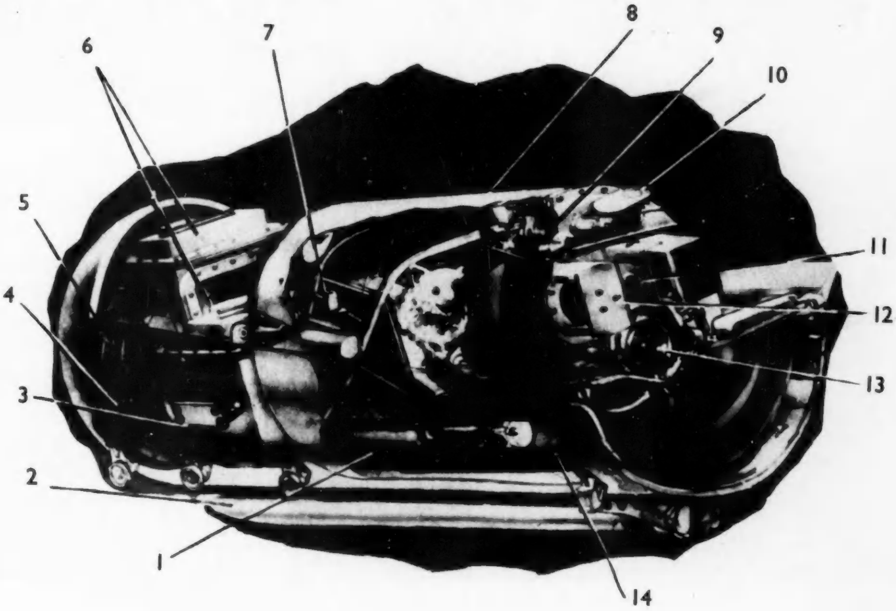


FIG. 2 (*right*). A cut-away view of the cabin showing:
(1) air supply tank;
(2) ejection-firing device;
(3) radio-bearing unit;
(4) battery for heating test tubes containing microbes;
(5) storage battery;
(6) scientific instruments;
(7) transducer to measure animal movement;
(8) pressurised container for animals;
(9) microphone;
(10) aerial for radio-bearing unit;
(11) TV camera;
(12) mirror;
(13) ventilator;
(14) automatic feeder.
(*Camera Press*)

FIG. 3. Belka and Strelka after their return.
(*Soviet Weekly*)

these tests were performed on the mice and rats too. Cardiovascular studies were made to see if the activity of the heart and the peripheral blood vessels of the dogs were affected by cosmic rays, the high accelerations, or weightlessness. Preliminary examinations after the flight have not shown any notable change. The immunological reaction of the dogs was also studied to see if the radiation or flight conditions lowered their natural immunity to microbes, thereby leading to the development of infections. Before-and-after tests were made of the phagocytal and bactericidal functions of the blood as well as the bactericidal properties and microflora of the skin. Similar studies of the effects of acceleration and vibration were made on the ground prior to the launching.

The work with the rats was begun several months before the flight. Studies were made of their higher nervous activity and their typological peculiarities were determined. Blood tests were made and electrocardiograms taken. The first post-flight examinations showed that the rats, like the dogs, took the trip well. The animals did not lose weight and their agility was normal. A careful examination revealed no scratches or bruises. Deep bone-marrow tests are being made on the mice to see if the radiation dose had any effect on their blood-making activity.

FIG. 4. Television images of Belka during the flight.
(*Camera Press*)

instead of films because the TV equipment took less space and required less light. It also precluded the possibility of losing all the information by some accident. The TV picture was filmed at the ground stations with time markings to permit correlation with other recorded and transmitted data. Mounted on the cradle in which each dog was strapped were transducers that provided additional information on the movements of the animals. Ionising radiation dosimeters were placed near the dogs and also on the suits they wore to measure the radiation dose from cosmic rays.

Metabolism studies were made before and after the flight to find out if there were any temporary or permanent changes. Before-and-after tests were also made of the albumen content of the blood and of certain ferments and hormones in the blood and urine of the dogs. Some of

EXPERIMENTS IN MICROBIOLOGY

The various microbiological and cytological specimens placed aboard the *Arknik* were intended to provide data on the effect of space-flight conditions on growth and genetic change.

Particularly sensitive indicators of the genetic influence of radiation are the so-called lysogenic bacteria which can produce bacteriophages when irradiated (Bacteriophages are ultra-microscopic parasites which enter into complicated genetic relationships with their bacteria hosts.) The effects of acceleration, weightlessness, and vibration were also of great interest. For this space flight, organisms were chosen which are widely used in laboratories all over the world in order to obtain results which can be subjected to comparison. Among the specimens were cultures of the

intestinal bacillus KK-12, with a basic strain well known to microbiologists and possessing the clearest genetic characteristics. Varieties of intestinal "B" bacilli and "aerogenes" were also included to study the frequency of mutations.

In order to examine the genetic changes in bacteriophages under space-flight conditions, the T-2 strain was used, since it is well known and has been rather fully described genetically. Also on board was the 13-21 bacteriophage strain which has a specific action on intestinal bacilli of the "aerogenes" type. It was added to study the changes in the nature of lysis (dissolution of bacteria which takes place in the presence of bacteriophage).

The butyric fermentation bacteria were placed in the satellite to work out methods of automatically recording and transmitting the vital activity of micro-organisms since such methods will make it possible to determine the period of survival of cells in space-ships making long flights and not returning to Earth. Soviet sources state this experiment "has fully justified itself".

The experiments with bacteria had one major shortcoming. These micro-organisms have a low radiosensitivity (although it can be increased somewhat, and was in some of the specimens, by exposure to oxygen). To get a clearer

picture of the genetic effect of the radiation in space, an attempt was made to utilise living cells in a tissue culture, since such cells are 100 times more sensitive to radiation. Cancer cells (He-La cells) were used because they normally grow well in artificial media and are widely used in studying genetic problems and the nature of cancer. The cells were cultivated by a method which makes it possible to obtain colonies on the sides of the test tubes in which they are propagated; experiments showed these colonies would resist vibration more severe than that which would occur during the launching. The viability of these cultures is now being determined and steps are being taken to preserve them in subsequent sowings. If the results are positive, the cultures will be used for genetic studies and compared with control cultures which remained on Earth.

The satellite also carried small pieces of human and rabbit skin. The samples of human skin, volunteered by Soviet scientists taking part in space research, were used to investigate the effect of space conditions on particularly sensitive cellular systems. Proof that these samples have returned in a live state can be obtained by histological studies, by sowing tiny bits in nutritive media (although such cultivation is, as a rule, extremely difficult), and finally by regrafting them on the donors. They are now being analysed.

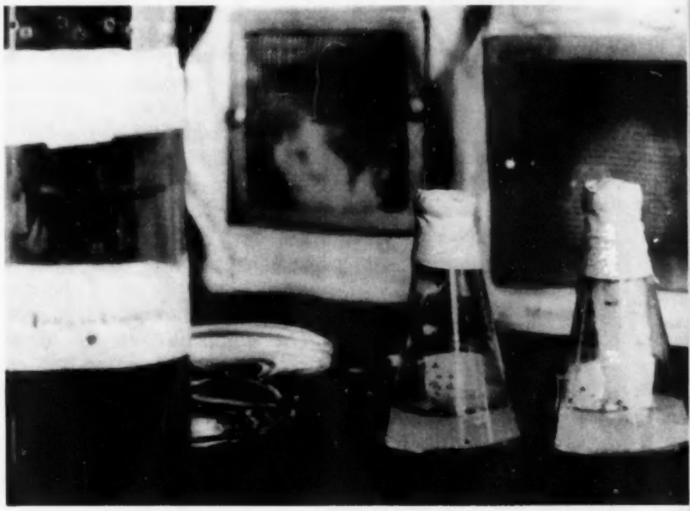
Desoxyribonucleic acid (DNA) was included in the array of specimens because this chemical, found in the nuclei of cells, participates in the transmission of genes from generation to generation. Soviet scientists are of the opinion serious deviations will not be found in the recovered sample because it was exposed to the radiation in space for a relatively short time. Delicate changes may have taken place, however, and these are being sought with physical-chemical, immunological, and other techniques.

FLIES, PLANTS, SEEDS, AND FUNGI

Drosophila were placed on board the satellite because they too are convenient subjects for genetic research. They multiply rapidly and their heredity has been well studied. Two lines were used—the D-32, which is distinguished by its very low mutability under natural conditions, and the D-18, which has a very high natural mutability. Crossing experiments are now being carried out to determine the frequency of the most important types of harmful mutations.

The *Tradescantia* plant is a classical subject of cytological research because it has a small number of chromosomes that are well distinguished from each other. Plants with buds were placed in the *Arknik* because it is easy to observe chromosome rearrangement in plant cells that are dividing at the time of pollen formation. The seeds of wheat, maize, and peas sent aloft will be planted to find

FIG. 5. Mice, rats, flies, and plant (in jar at left) after recovery.
(United Press International)



out if mutations occurred in these also. The onion and *Nigella* seeds will be used, in the main, for cytological research.

Since ionising radiation is extensively used to obtain new and highly productive strains of *Actinomyces* (which provide such valuable antibiotics as penicillin and streptomycin), two strains of fungi—producers of penicillin—were placed in the satellite to obtain another measure of the biological effectiveness of cosmic radiation. The two strains selected had widely different radiosensitivities.

Since it is possible that algae may be utilised for the recycling of air and food on long space-trips in the future, the Soviet scientists considered it important to study the effect of space-flight conditions on one of the green algae which appear to be suitable for recycling. Samples of *Chlorella* were sent aloft in special ampules in different physiological states, on inclined agar-agar and in a liquid nutritive medium with varying densities of suspension. Some were kept in light places, others in darkness. Studies are now being made of the morphology of the cells, the photosynthetic activity, the growth process, the changes in heredity, and so forth.

COSMIC RAY EXPERIMENTS

The *Arknik* carried counters sensitive to cosmic-ray particles ranging from helium to oxygen nuclei. They were basically Cerenkov counters controlled by a telescopic arrangement of halogen discharge counters. This equipment was apparently included to obtain data on the ratio of nuclei of the carbon-nitrogen-oxygen group to those of the lithium-beryllium-boron group, since this information would throw some light on the origin of cosmic rays. The wording used in Soviet reports makes it appear that the experiment was unsuccessful. In addition to this equipment, the satellite carried an integrating Cerenkov counter for measuring streams of heavier nuclei. The Soviet scientists, in this instance, reported the successful detection of tenfold increases in the intensity of streams of nuclei having a charge of more than 15, and correlated these bursts with the radio emission from the Sun. This was the first time relativistic heavy nuclei have been observed originating in the Sun.

Several blocks of heavy-layer emulsion were also sent aloft for cosmic-ray research; one of them was automatically developed on board after an exposure of about ten hours—apparently to safeguard against the possibility of tracks from rare particles being lost in a snowstorm of tracks from the more common particles. One of the emulsion packs (there apparently were four) was an FE-2 block to record elementary nuclear interactions of high-energy particles of the order of 10^{12} electron-volts or more. It consisted of a 10-cm.-square stack made up of alternate layers of emulsion (400 μ thick) and lightweight "target" material (1 mm. thick). The emulsion and the target material together served to register the interaction of high-energy nucleons with the heavy atoms in the emulsion and the light atoms in the target metal. The neutral pi-mesons produced by the high-energy particles gave rise to photon showers, which were recorded on a detector above the stack. The detector consisted of seven thin lead plates with layers of emulsion and fluorescent avalanche indicators sandwiched in between. This experiment is expected to provide some fundamental information on the interaction of primary cosmic-ray particles with light and heavy nuclei. The satellite also carried F-1 and F-2 nuclear emulsion units, each with a volume of 0·8 litres.

To measure the variability of the great radiation belts and occasional spurts in cosmic-ray activity, a dosimetric assembly that included two gas counters and two scintillation counters was placed in the satellite.

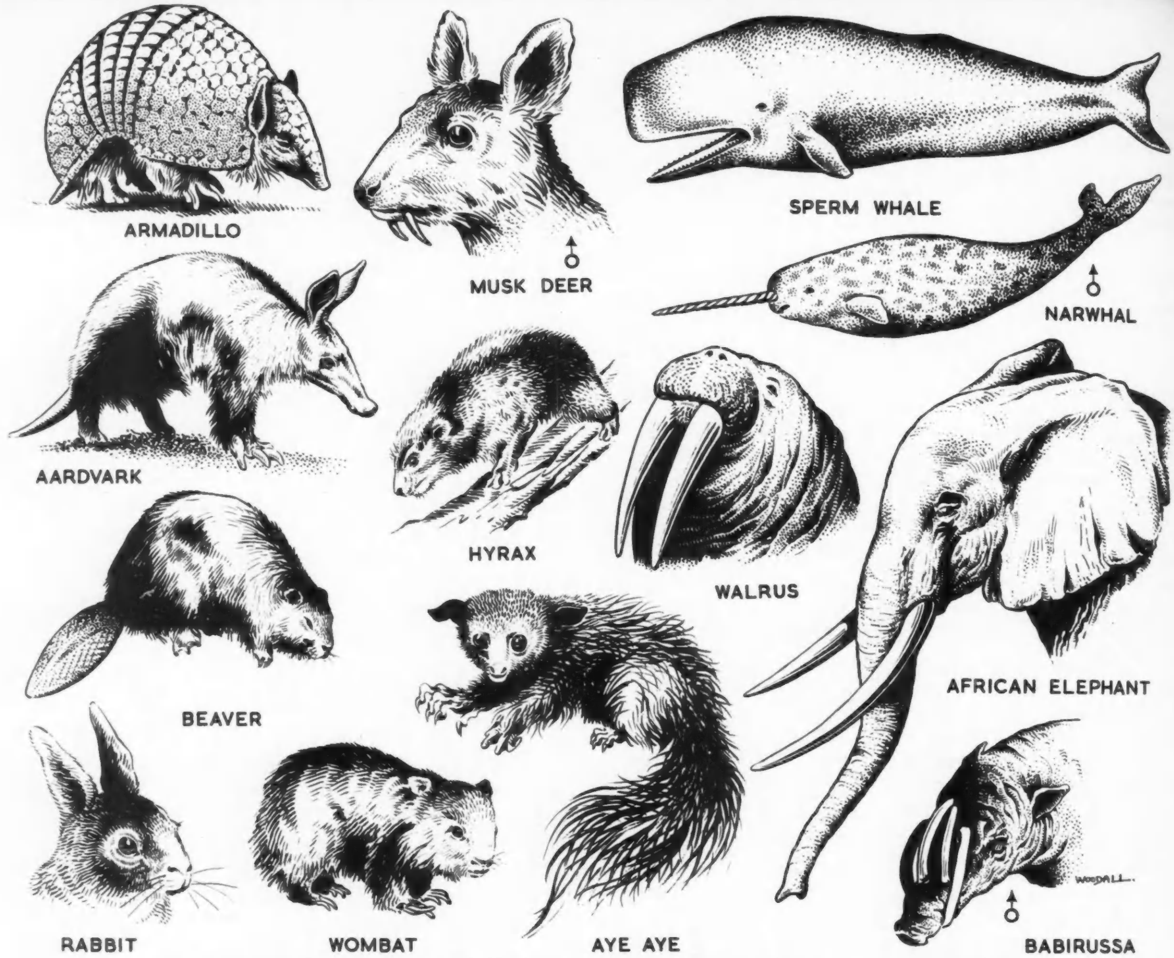
SOLAR RADIATION

There were also two instruments for studying the short-wave radiation of the Sun. The first had six receivers "to increase the probability of solar radiation falling on one (but never more than one) at any orientation of the satellite". They were probably arranged in pairs, back to back, along three mutually perpendicular axes. The receivers were windowless electronic multipliers. Placed in front of each was a disc holding seven filters that was shifted around so that each of the filters was positioned in front of the electrodes in sequence, at one second intervals. The first filter let the 1·4 to 3 Å band of radiation through, the second passed everything under 12 Å, the third passed the 8 to 20 Å band, the fourth passed the 44 to 100 Å band, and the fifth singled out the 1216 Å Lyman-α hydrogen line. The sixth made it possible to measure the continuum radiation in the region of the Lyman-α line, blocking much of the 1216 Å radiation and thereby allowing a more accurate Lyman-α determination from the reading with the fifth filter; the seventh passed radiation with a wavelength of more than 1500 Å to estimate the change in angle of the satellite relative to the Sun. The second instrument for studying short-wave solar radiation was designed to measure the intensity of soft X-rays emitted from the corona near the short-wave cut-off of the normal spectrum, primarily during flares. Measurements were made in two regions of the spectrum—3 to 6 Å and 6 to 10 Å. For each there were six counters (a total of twelve) grouped in three blocks. Counts were stored in a memory unit until they could be transmitted to Earth. A system of magnets and diaphragms was placed in front of each counter to deflect the electrons in the great radiation belt that would otherwise produce spurious effects.

The short-wave solar radiation detected with these two instruments is to be compared with ground observations of the ionosphere, visible chromosphere flares, and other phenomena connected with the activity of the Sun to see if the processes observed in the outer layers of the Sun can be correlated with those occurring in the Earth's atmosphere.

SCIENCE OR STUNTS?

There has been considerable criticism in the West of the Soviet space programme. Many have charged the Russians with being more interested in the propaganda value of their space "stunts" than they are in solid scientific achievements. The reports on the *Arknik* experiments make it quite clear that Soviet scientists and engineers are exploiting the scientific opportunities offered by their highly successful programme.



CONTINUOUSLY GROWING TEETH

A. R. NESS

Mammals adapted to eating plants usually grind the food minutely between their back teeth. The resulting wear on the teeth itself presents a problem for survival.

Mammals adapted to eating plants usually grind their food minutely between their "cheek teeth". Such grinding produces extensive wear, particularly when grasses form a major component of the diet. To obviate curtailment of life by premature loss of teeth through wear, two evolutionary possibilities appear open. The one is to replace the worn tooth by a successor, and mammals generally do replace a "milk" dentition by larger "permanent" teeth. A few species—elephants, for example—have their permanent cheek teeth so large that one or two at a time suffice to fill the grinding area of each side of the jaw. In these mammals, "continuous succession" has been achieved by spreading the development of the permanent cheek teeth over the lifespan. The other possibility is that the worn tooth should itself grow continuously and it is with this evolutionary development that we shall now concern ourselves.

In this type of replacement there is a continuous proliferation of the tooth-forming tissue at the base of the tooth. Each tissue element, as formed, moves "up" through the tooth socket from the base towards the mouth, laying down the dental hard tissues as it goes. The result is that, where wear occurs of the erupted surface, the lost tissue is immediately replaced by eruption, so that the apparent crown of the tooth never wears down. As has been discussed by D'Arcy Thompson (1942), an organ whose growth is expressed in continuous accretion of dead materials—the shells of molluscs, the nails, horns, and teeth of mammals—produces a characteristic shape in its end-product. Thus the cross-sectional area of a continuously growing tooth will increase with age, although the increase may be so slight in adults that the cross-section remains effectively constant. Another characteristic is that the distribution of hard tissues remains similar from one

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cross-section to the next. Since continuous growth of teeth over the lifespan has been verified in but few species, increase or maintenance of the cross-sectional area may be held diagnostic of continuous growth, provided that old individuals are included among the examples of the species being studied.

OCCURRENCE AMONG MAMMALIAN ORDERS

Discussion will essentially be confined to existing mammals, a number of which are shown opposite, but the form of teeth indicates that continuous eruption developed in many mammalian orders now extinct—for example, the Multituberculata, Tillodontia, and Taeniodonta. Continuously growing teeth may be gathered into five groups:

1. Batteries of continuously growing cheek teeth enabling their possessors to grind plant food. Such are seen in some marsupials (wombats), in Lagomorpha (rabbits and hares), and in some of the Rodentia (for example, the guinea-pig). The cheek teeth of many other herbivores have evolved in this direction, growing through most of the lifespan but eventually forming distinct roots and, while continuing to erupt, ceasing to grow in length. Such are found in many ungulates (such as the horse) and rodents (such as the beaver and the porcupine) and in the elephants.

2. Batteries of continuously growing cheek teeth such as are found in the Edentata. These lack enamel, being composed of a core of vascular dentine surrounded by a layer of harder, "true", dentine. It has been suggested that this order evolved as specialists in the consumption of social insects—ants and termites. Some of the living edentates still are but the ant-eaters of the family Myrmecophagidae have "lost" all their teeth; the armadillos take a very mixed diet of plants and animals while the sloths subsist mainly on leaves. Similar cheek teeth are found in another termite-eater, the aardvark, which is thought to be related to the ungulates.

3. The lower jaw of the sperm whale is armed with about fifty-four large conical teeth, with which the main prey—large squid—is seized, and whose form is indicative of continuous growth. The much smaller upper teeth are mostly non-functional and the considerable wear of the lower teeth is mysterious, since the squids on which the whale feeds do not carry a cuttle on which the teeth might be worn down in prehension. It is not certain that these teeth do maintain growth throughout the lifespan; in old animals the teeth may taper basally and the pulp chamber become filled with irregular dentine. Other toothed whales, such as the Ganges dolphin *Platanista*, may also have continuously growing teeth.

4. It has long been known that the incisor teeth of rodents grow continuously. In the order Rodentia (squirrels, rats, porcupines) the only anterior teeth are the pairs of incisors in each jaw, forming a gnawing unit separated by a distinct gap from the grinding cheek teeth. The arrangement of hard tissues is such that wear maintains a sharp chisel edge to the incisors; enamel is present on the leading surface only. The possession of these incisors in part accounts for the success of the rodents, seen in their distribution through all continents except the Antarctic and all environments except the high seas. Rodent incisors, besides being efficient cropping organs, enable their possessors to make available food sources (hard-shelled nuts, for example) denied to other small mammals and to work on their environment, as seen in the beaver, which builds dams and homes from the trunks and branches of trees. The Lagomorpha have developed similarly to the true rodents, but are probably not closely related. Rodent-like incisors occur also in one member of our order, the Primates (the aye-aye); in the wombats, which are marsupials; and in the hyraxes, which form an order whose closest living relatives are the elephants.

5. Tusks—continuously growing anterior teeth—include the largest and some of the most curious of teeth. Pigs have developed canine teeth, particularly the males. In the wild boar, the upper and lower tusks meet and wear against each other, thus remaining sharp and dangerous weapons. In another pig, the babirussa, the four tusks grow upwards over the face, a development such that no functional contact is made during chewing. In the related hippopotamuses, all the anterior teeth are continuously growing, forming a powerful cropping organ equally qualifying for inclusion in the fourth group above.

The walrus, a carnivore related to the sea-lions, has continuously growing upper canine tusks, in both sexes, used in food-gathering (the primary diet being molluscs collected from the sea bottom) but also in fighting. The dugong, a sirenian disappointingly unlike the mermaids whose legend it probably inspired—has downward-pointing tusks in the upper jaw that are usually erupted and functional only in the male. Some primitive deer develop formidable upper canine teeth as weapons, in the males; in the musk-deer these are continuously growing.

The African elephant presents the most prodigious of all teeth (longest known 12 ft., heaviest over 2 cwt.) in the tusks carried in the upper jaw. Some extinct proboscoideans carried tusks in both jaws, others in the lower jaw only. It is generally held that the extinct *Moeritherium* was an early proboscoidean, and it is notable that this animal had small upper and lower incisor tusks which apparently met functionally in chewing. The elephantine tusk therefore is probably an example of an organ developed ancestrally for one purpose, namely for cropping food, which subsequently evolved to a different purpose, in this case as a tool and weapon and also, perhaps, as a weight to help balance the massive hindquarters over the forelegs (Young, 1950).

The remaining tusk to be considered has also been "liberated" from any function as a chewing organ. An Arctic whale, the narwhal, grows to 16 ft. long and as an adult has but a pair of teeth, in the upper jaw. In the female these usually remain buried in the head and are about 8 in. long. In the male, however, the right is similar to those of the female but the left grows out into an almost straight tusk, up to 9 ft. long, with spiral markings on its surface, the spiral being in the same direction in all individuals. Readers will see here, correctly, the origin of the horn of the unicorn as portrayed in heraldry. Rarely, and then apparently sometimes in the female, both teeth develop into tusks: when they do the spiral on both is in the same

direction. The sex linkage and usually asymmetrical development of this fantastic tooth, the formation of its spirals of constant direction, and the uses to which it is put are probably so fascinating that it is a pity the cost of observing narwhals, let alone of obtaining and maintaining them for close study, is at present prohibitive.

THE STUDY OF RODENT INCISORS

From the above survey, it is seen that teeth of continuous growth have evolved extensively among the mammalian orders and not only to overcome the special problems associated with mainly plant diet. It seems that the evolutionary change from limited to continuous growth is an "easy" step and may be assumed to involve the continuation of processes, such as are responsible for the eruption of teeth of limited growth, over the lifespan of the individual. The occurrence of both sorts of teeth in the one animal (for example, the rat) indicates that the change is not that of a central controlling mechanism. It is hardly surprising that common and cheap laboratory animals (rat, guinea-pig, rabbit) have been used in the experimental study of the continuous growth of teeth. From such studies we may hope for information of interest to many fields of biology beyond that of the growth and eruption of teeth, which is itself of only limited interest to dental medicine. A study of normal growth may elucidate, by contrast, the processes underlying abnormal growths, notably some forms of cancer, but also, for example, the clubbing of finger ends which is a symptom of a puzzlingly wide variety of circulatory and respiratory diseases. Again, continuously growing rodent teeth have been used as indicators of the effects of induced hormonal and dietary disturbances. For example, the teeth of the guinea-pig are peculiarly sensitive to a deficiency of Vitamin C. The dental hard tissues change little, if at all, once formed; they may thus provide a record of an induced disturbance to which it is fairly easy to fit a time scale. Recently, continuously growing teeth have been used in studies of the uptake and effects of "bone-seeking" elements such as radioactive strontium. Such experiments often provide valuable information on the physiology of normal rodent incisor growth but, conversely, the interpretation of such experiments is limited by our ignorance of normal growth. Lastly, if one understands their growth, one may better understand the forms of teeth and thus better interpret the fossil record.

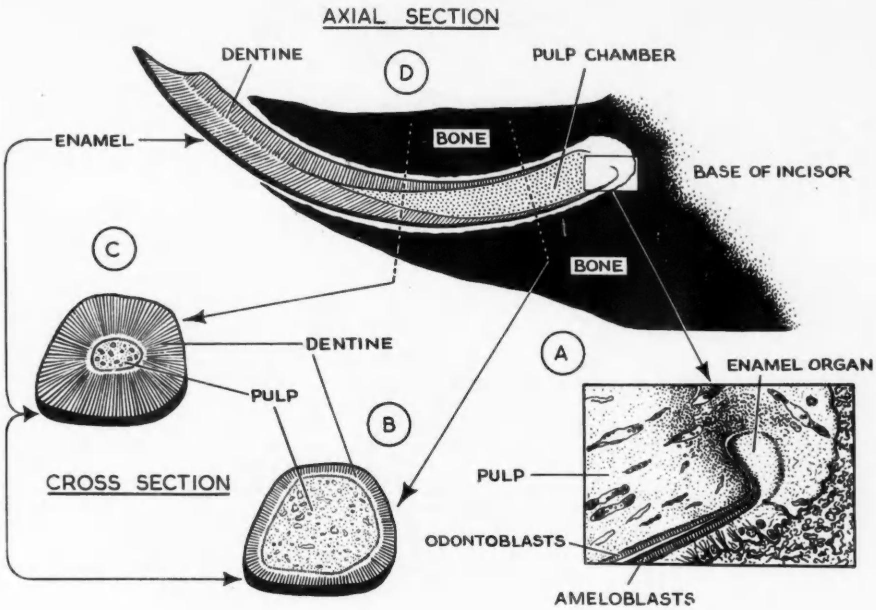
As an object for the study of tissue growth, the rodent incisor is distinguished by growing when general body growth has ceased; thus its rate of growth can be measured from fixed points of reference provided by surrounding structures. Further, its growth is linear rather than radial and the end-product, the tooth itself, has a comparatively simple outline with smooth surfaces, all factors making for ease of measurement.

SOME FEATURES OF RODENT INCISOR GROWTH

Rat, guinea-pig, or rabbit incisors erupt at about 0·3 mm./day under normal laboratory conditions. When an incisor is relieved of biting pressure, by experimental shortening of the incisor itself or of opposing teeth (and also by continuous heavy wear such as might occur in the wild state), its eruption rate rises to about 0·7 mm./day. These measurements are of the rate of extrusion of tooth past a fixed point—the gum margin, or a bony margin seen in X-radiographs. When eruption rate is increased experimentally, the base of the incisor retains its position relative to the surrounding structures. This could only happen if the rate of formation of tooth-forming tissue, at the base, were tied to the rate of eruption: under these conditions, measuring the one is equivalent to measuring the other, in the adult. If eruption rate is increased over a few weeks, the pulp chamber becomes enlarged compared with that of an incisor erupting at a slower rate. This can be attributed to the rate of deposition of dentine on the surface of the pulp *not* increasing when the eruption rate increases. Since under these conditions the pulp *does* increase in volume, it seems that the pulp itself is continuously growing.

All the evidence suggests that in the adult animal the tissue below the base of the incisor pulp is as unchanging as is most connective tissue in the body but that in the pulp, somewhere near the base of the incisor, tissue is formed continuously (Ness and Smale, 1959) and moves "forward". If this is accepted, there is the following consequence: as dentine is deposited, the cross-sectional area of the pulp decreases. Thus either the pulp tissue must become incorporated into the dentine, or it is progressively resorbed. Now normal dentine, unlike bone, has no cellular inclusions, although these can be seen in the "dentine" formed by guinea-pigs deficient in Vitamin C. Therefore the cells of the pulp *must* be progressively removed as the pulp decreases in cross-section, although some remnants of the odontoblast layer appear to be incorporated in the osteoid plug which is formed to seal off the tip of the pulp chamber. It is now becoming recognised (Glücksmann, 1951) that cell death and resorption is as much part of development as is new cell formation. The fate of the non-cellular components of the pulp (fibres and ground substance) is not known: it is likely, however, that they are also progressively resorbed and that the odontoblast layer lays down a fresh organic matrix, with special fibre orientation, to form the dentine. It has long been known that growing bones are moulded by the deposition of bone in some regions and resorption in others. Bone grows by apposition and resorption at surfaces, being a rigid, mineralised structure. Soft connective tissue, in contrast, is able to grow "interstitially"; that is, new tissue elements can form between existing elements. Thus, as the tissue grows, addition is being made to its substance throughout its volume.

The growth cycle of the rodent incisor pulp appears to illustrate well the creative interaction of the "opposing" processes of formation of tissue and of its resorption. Ness and Smale (1959) studied the distribution of mitoses—that is, the formation of new cells by division of existing ones—in the rabbit incisor. The base of the pulp was confirmed as the region of active cell proliferation: 85% of pulpal mitoses occurred in the basal 2 mm. Nothing is known yet of the relation between cell proliferation and the formation



Rabbit lower incisor. (*a*) shows the region of production of the cell layer (ameloblasts) concerned in the deposition of the hard *enamel* on the leading surface (*b*, *c*, *d*), an arrangement which promotes maintenance of a chisel edge (*d*). (*a*) also shows the emergence of part of the *odontoblast* layer, which lines the pulp chamber and organises the dentine, whose deposition gradually reduces the pulpal cross-section (*b*, *c*, *d*).

of new extracellular material, though it is generally supposed that the formation of solid components is mediated by enzymes produced in cells near by. Gagan and Ness (1960) published some preliminary findings on cell resorption along the growth axis of the rabbit incisor pulp. They found that cell number fell from base to apex of the pulp —as must have been expected on the arguments given above—but that, after a fall in cell *density* over the basal 1 mm., density was maintained at a steady level, even increasing in the terminal portion. These results suggest that non-cellular matter of the pulp is resorbed concomitantly with the cells. Perhaps, in these later stages of the life-cycle of pulpal tissue, the cells that at the base mediated the formation of extracellular solids turn to the production of enzymes breaking down those solids.

THE FORCE OF ERUPTION

It is apparent that the movement of the incisor through the surrounding tissues requires the development, somewhere, of a mechanical force. It might be thought that the surrounding tissues dragged the tooth forward. There is experimental evidence against such a process operating here and it will not be discussed further. There stand for consideration two hypotheses, both of respectable age; indeed they might be called classical were it not that there is no direct evidence for either! The hypothetical forces are due to (i) "tissue growth" and (ii) hydrostatic pressure of the pulpal tissue fluid, derived from the blood pressure and ultimately from the force of the heartbeat. Concepts of "tissue growth" have been vague. It is tempting to presume that cells can draw in material using energy derived from chemical transformations and, in swelling, exert a pressure outwards on their surroundings. It is to be noted that were this so, such a force would appear as general tissue pressure, except perhaps in the special cell layers where cells jostle against each other. In favour of the tissue pressure hypothesis, experiments have been cited in which a lowered rate of incisor eruption has been associated with a decreased "vascularity" of the incisor pulp. But change in vascularity has been assessed from microscopic sections, qualitatively, and is thus suspect. Were such observations made quantitative, they would still tell us little of flow or pressure in the vasculature and, in any case, such changes might well affect cell metabolism and proliferation as much as the hypothetical tissue pressure. It is obviously now important to attempt to measure the force exerted by the erupting tooth as a step to understanding the generation of that force. Growing tissue is often assumed to exert a force on its surroundings but direct measurements of such forces have yet to be made in animal tissues. The rodent incisor may be a suitable object for experimentation, since the growing tissue in it is attached by nature to a handle suitable for the application of measuring devices.

REFERENCES

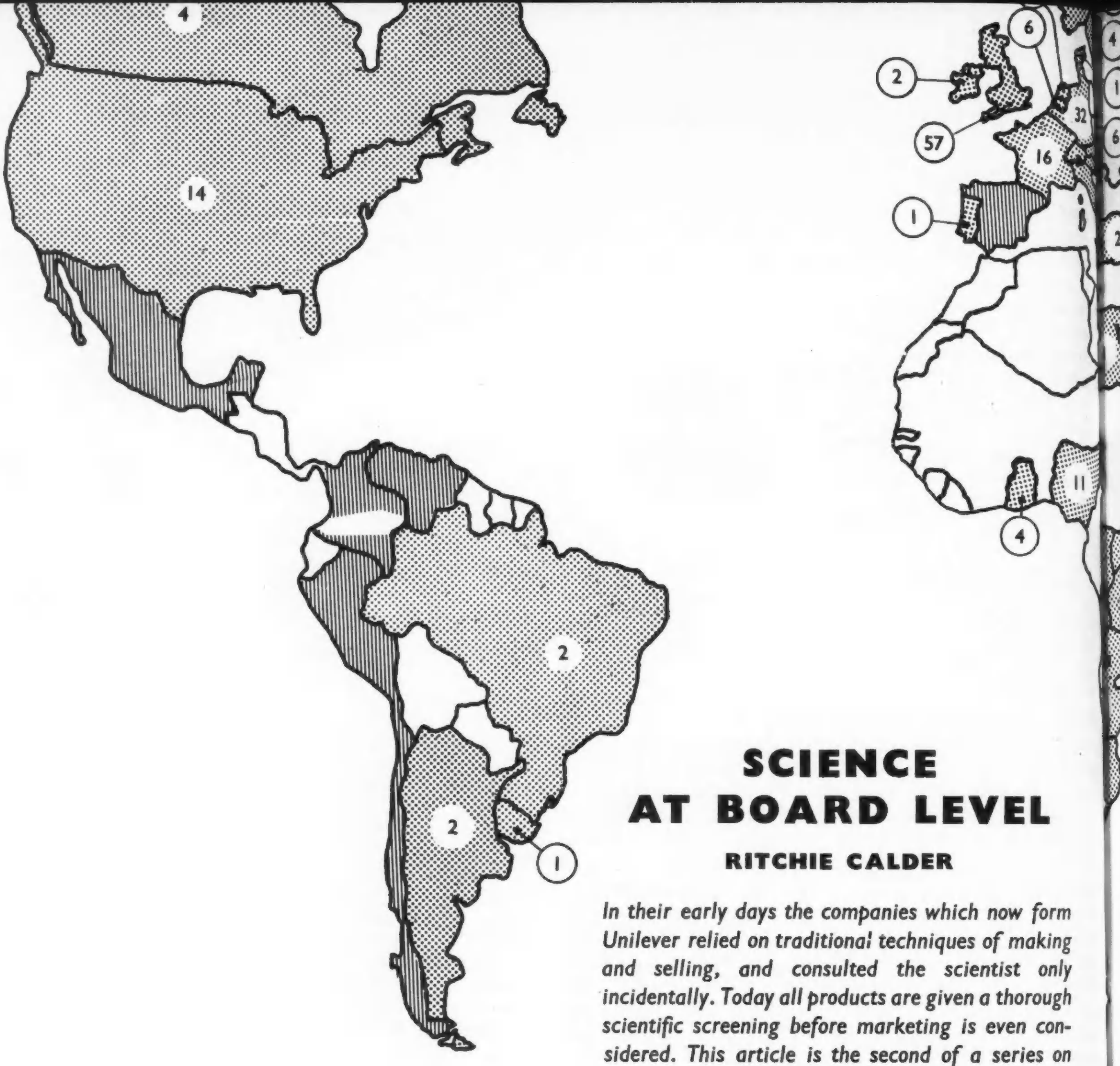
Glücksmann, A., 1951, "Cell Deaths in Normal Ontogeny", *Biol. Rev.*, vol. 26, p. 59.

Gagan, E. A. T., and Ness, A. R., 1960, "Changes in Cell Density Along the Growth Axis of the Pulp in the Continuously Growing Rabbit Mandibular Incisor", *J. Physiol.*, vol. 151, pp. 33–5.

Ness, A. R., and Smale, D. E., 1959, "The Distribution of Mitoses and Cells in the Tissues Bounded by the Socket Wall of the Rabbit Mandibular Incisor", *Proc. Roy. Soc. B.*, vol. 151, p. 106.

Thompson, D'A. W., 1942, "On Growth and Form", 2nd ed., Cambridge Univ. Press.

Young, J. Z., 1950, "The Life of Vertebrates", Oxford Univ. Press.



SCIENCE AT BOARD LEVEL

RITCHIE CALDER

In their early days the companies which now form Unilever relied on traditional techniques of making and selling, and consulted the scientist only incidentally. Today all products are given a thorough scientific screening before marketing is even considered. This article is the second of a series on the role of science in industry.

Unilever is a commercial empire on which the sunlight never sets.

Its interests extend from Guadalcanal, through Australasia, S.E. Asia, the Middle East, Europe, Africa, the two Americas, and back to the Far East. They reach northwards and southwards to the Poles (over a tenth of its raw materials come from Antarctica). Unilever consists of 400 active companies, trading in 50 countries and in 40 currencies. Its plantation properties cover 200,000 acres in the Belgian Congo, Nigeria, Cameroons, Ghana, Gaboon, Malaya, and the Solomon Islands. It owns 260 factories. It runs shops and it runs ships.

Unilever has a capital of £526 million. Its turnover in 1959 was £1787 million which, as a figure, is about half the Civil Estimates of the British Government. Throughout the world it employed 283,000 workers. In the United Kingdom, it operates through companies with forty-two different names, most of them household words.

The origins of this great enterprise were not scientific, like, for example, that comparable giant, Imperial Chemical Industries (Capital: £350,000,000), and for that very reason Unilever is being considered in this examination of "Science at Board Level". How does science come into, and find representation and expression in, a commercial organisation as diversified as Unilever?

One of the senior scientists of Unilever tells how, in earlier days, he took his scientific degree into one of the associated companies and introduced himself to his industrial colleagues. "But", one of them said in genuine surprise, "we have a research chemist already!"

Certainly, scientific considerations did not much actuate

Journalist Ritchie Calder has written extensively on scientific development throughout the world.

William Lever, the Bolton grocer, when he first bought his soap in bulk from existing soap-boilers and wrapped the bars in his own brand labels; nor, at the outset, did it influence the rival families of Jurgens and Van den Bergh, in the little Dutch town of Oss, when they each decided to expand their dairy-butter businesses by making a butter substitute on the basis of the invention of the Frenchman Mège Mouriès.

True, when William Lever decided to go into the manufacture of cleansers as "Lever Bros." he engaged a chemist, but the indispensable acquisition was a practical soap-maker, in the father-to-son tradition of the industrial arts. The qualified chemist could help to standardise the quality of the raw materials used and the marketed products. But the branded soap which swept Britain (and the world) as "Sunlight" was less the formula of the chemist than the recipe of the soap-boiler. The chemist was able to explain why nut oil had an irritating effect on the skins of many people and how cotton oil made the soap unfit for laundry use, but it needed the empiric skill of the soap-boiler to produce the bulk-manufacturing techniques which could use proportions of both, without the faults of either.

Lever's success depended on not-too-subtle chemistry and a shrewd, behind-the-counter, sense of consumer research. He pioneered branded goods (Sunlight Soap, Life-buoy Soap, Monkey Brand, and Vim) with advertising campaigns and free gift devices which drove his competitors out of business—or, rather, into his.

STRICTLY PRACTICAL RESEARCH

Later, as the autocrat of a great corporation, he approved the creation, extension, and manning of laboratories in the many companies which his personality dominated, but it was strictly practical research—analytical, quality control, and developmental. Original research, even speculative research, was, to him, an unbusinesslike luxury. Needs

Port Sunlight plant (England) of Lever Brothers, one of the companies in the Unilever family. This factory produces soap products and is the largest unit in the Unilever chain, employing 3500 workers. The research laboratory here, directly under Unilever, carries out research on soap, non-soapy detergents, adhesives, and chemicals.

dictated and research would meet those needs—no more, no less. Outside his business he believed in science as an ideal to the extent of leaving a fortune to endow, through the Leverhulme Trust, something which he called "research" but which, in his will, he failed to define, to the continuing embarrassment of the Trustees.

Across the North Sea, the two Dutch families, Jurgens and Van den Bergh, had begun as the middlemen in the butter trade, buying up farm supplies and selling it to the prosperous classes in Britain. Their experience of the British market made both firms aware of the opportunities for margarine. They started from the simple fact of what the workers could afford. The original "know-how" in relation to margarine was crude—the refinements of research were to come later.

All three, the soap-maker and the two margarine-makers, were dependent on the same raw materials—animal fats and vegetable oils. For forty years, they competed against each other for the raw products of the abattoirs and the plantations; as early as 1900, Van den Berghs had gone into soap-making to the detriment of Lever's European sales and, during the First World War, Lever Brothers had entered the margarine field. First, the Dutch companies amalgamated, and then, in September 1929, they went into formidable partnership with Lever Brothers as "Unilever".

But Lever Brothers had come into the food trade in another way—one might say, through an unsuspected romantic streak in William Lever, the first Lord Leverhulme. Contemplating his retirement, he had bought two Hebridean Islands, Lewis and South Harris. It was entirely his personal venture and had originally nothing to do with the company. He wanted to be a 20th century "Lord of the Isles", generous to the point of indulgence but feudal in his intent to reorganise the lives of the islanders. He planned to modernise and extend the fishing and tweed industries, to build ports, canning factories, roads, gas works, electric plants, laundries and other industries. But he lost his way in the Celtic Twilight. He retreated, baffled by Gaelic suspicion and official red tape, saying: "I am like Othello, with my occupation gone and I could be like the ghost of Hamlet's father, haunting the place as a shadow."

But in his zeal to create a reliable marketing organisation for the island fishermen, he had already bought a chain of retail shops. By the end of 1921, Mac Fisheries, his creation, already owned 360 shops (and are now, of course, the feature of every High Street.) To supply them, he had acquired trawling interests, oyster beds, and the "Skipper" fish-canning business of Angus Watson and Company, of Newcastle. As part of the stock-in-trade of his fish shops, he had taken over the Walls Sausage Firm and found himself in the ice-cream business. (Walls, as an offset to the traditional summer slump in sausages, had started the "Stop-me-and-Buy-One" ice-cream tricycle trade.) Other food businesses were bought by Lord Leverhulme, including one which was in the gourmet range of tinned skylarks and the like.

In 1922, he sold them to Lever Brothers and they were part of the "marriage portion" which went into the union, which became Unilever. In course of time, they acquired baby foods, the frozen-foods firm of Birds Eye, and the Sheffield firm of Batchelors Peas.

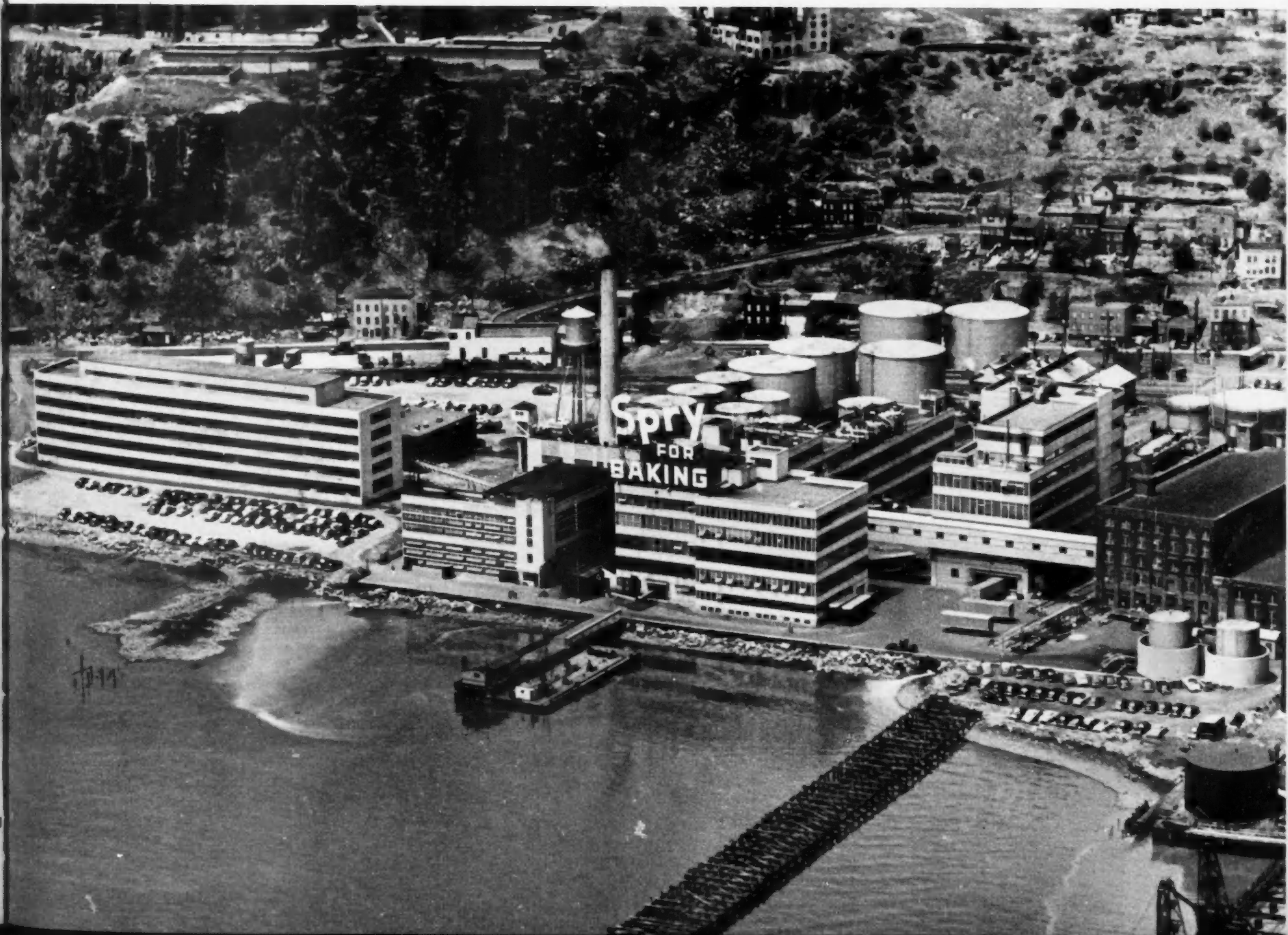
Enough has been said to show the vast ramifications and diversity of Unilever and to reinforce the questions: Where does science figure in all this? Who are the arbiters of the claims of research, and how does science get through to board level?

Historically, it is clear that, in the two main structures of the business (soap and margarine) research was an auxiliary rather than an initiator. The research facilities had continually increased and the horizons of inquiry had continually expanded. In the highly competitive situation, not only with outside rivals but inside the organisation itself, improvement and novelty had become compulsive. As TV commercials continually remind us, there has been no lack of scientific ingenuity—optical salts in soaps and detergents, which makes laundry "whiter than white"; the ingredients which make the teeth gleam if you use the right toothpaste; and the margarine which is indistinguishable from butter, except that it is "easier to cream". Quality control, both in the basic materials and in the end-products, is sternly and expensively maintained. With the latest chromatographic apparatus, the chemists can isolate the trace-substance which can cause off-flavour—a trace which can offend the palate even although it is only a tenth of a milligramme per ton of vegetable oil. Finding it is like searching for a particular speck in a waggon-load of sand.

All this costs a lot of money, even although it is a tiny fraction of that £1787 million turnover, and at some stage requires the sympathetic understanding of a money-allocating board. But there are forty-four associate companies, the boards of which are responsible for their own "housekeeping". They will be judged, not by their attitude to research *per se*, but by the commercial results. They do not need the approval of the parent board for expenditure on laboratories or staff, but, by definition within the organisation, that is "development" not "research". Research rests with Unilever.

CRITERIA FOR RESEARCH

The Unilever organisation consists of two holding companies, Unilever Ltd, the British company, and Unilever N.V., the Dutch company. The Board of both consists of the same people; the distinction is a legal matter. The maximum number of directors is twenty-five but there is



Edgewater plant (New Jersey) of Lever Brothers produces margarine and cooking fats. Five-storey building at left is the Research and Development Center, directly under Unilever, where studies are carried out on soup mixes, canned foods, margarine, salad dressing, and other food products.

no deliberate apportionment of Dutch or British representatives because it is an integrated organisation and not a balance of two factions. Apart from the "Special Committee", which comprises three "Ministers without Portfolio", the members of the Board all have executive managerial appointments. The Board members are divided into two categories—the management of particular sides of the business and the heads of the major service and Advisory departments, of which the Research Division is one. The Research Director, therefore, wears two different coats. He is executively responsible for research, for the establishments, and for scientific personnel, but he changes that coat when he sits once a week as a member of the Board. In the day-to-day discussions of research requirements he deals with the "Special Committee". Any research proposals would be presented to the Board by the Chairman, and the Research Director, as a Board member, is then expected to be, not the judge in his own cause but a member of a tribunal considering the claims of the Research Division as a strictly business proposition. With him on the Board are two Technical Directors responsible for development in Britain and abroad.

The Unilever Board considers research according to certain criteria: (1) adequacy, (2) protection, (3) emphasis, and (4) prediction.

"Adequacy" is a matter of organisation. Can the existing research facilities handle the proposed research? Can the existing sales organisations market the possible products of such research? The decision would not be dictated by existing arrangements. A research establishment might be extended or a new establishment created. If the results were likely to be a new commodity outside the range of the products of the associated companies, a new company might have to be created. Therefore, a "good idea" still unproven would imply a heavy capital investment.

"Protection" means the continuous improvement of existing products. This means the continual study of the nature of the products so that a well-established "line" can be adapted to answer the challenge of a competitor or to meet and even anticipate the changing habits (or whims) of customers. (The manifest results of "protection" are obvious to the televiewer watching the commercials.) But in a big organisation like Unilever, "protection" and the research behind it affects the members of the "family" as well. Each company has to fight its own marketing battles but a new research development might seriously threaten a "best-seller" and at Board level this would be a matter of concern. It would not be a question of suppressing a new development (because an outside competitor might intro-

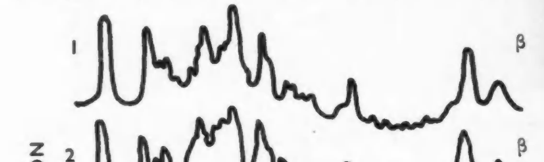
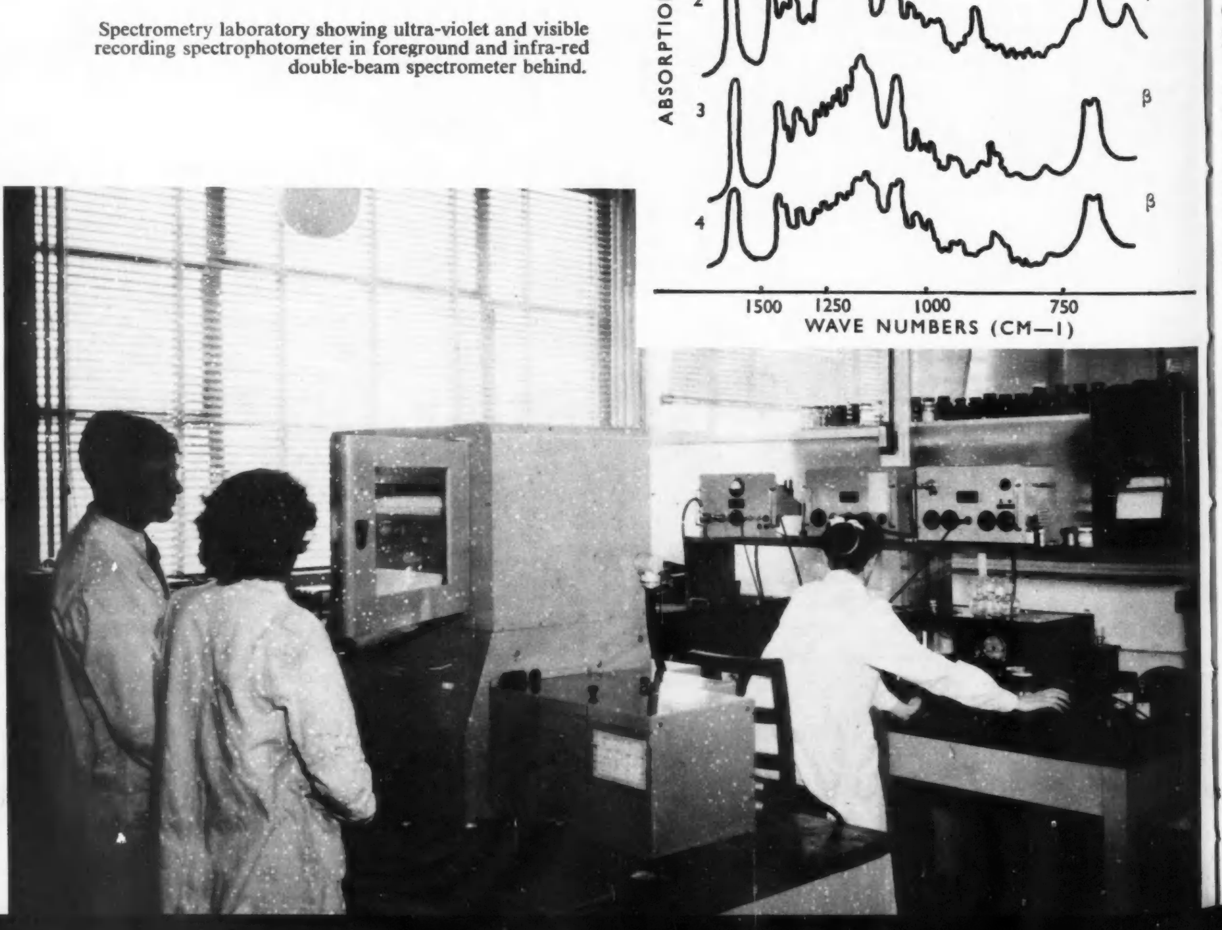
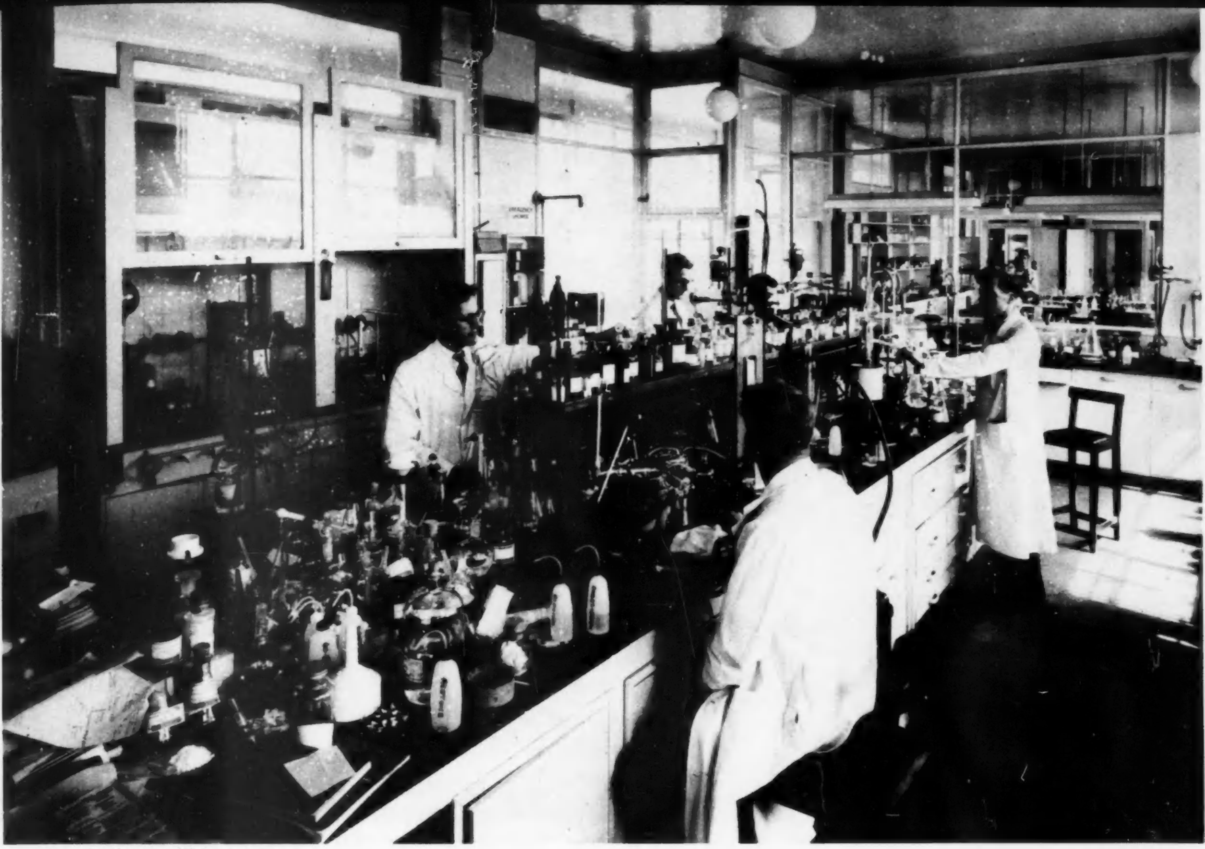


Chart shows infra-red absorption characteristics of major glycerides of cocoa-butter and lard: (1) 2-Oleopalmito stearin, (2) Cocoa-butter, (3) 2-Palmito oleo stearin, (4) lard fraction.



Spectrometry laboratory showing ultra-violet and visible recording spectrophotometer in foreground and infra-red double-beam spectrometer behind.



Organic chemical laboratory.

duce it anyway) but, by research, transforming the existing product to meet the new challenge.

"Emphasis" is also a matter of Board judgment. Even with big laboratories, the cost of research in the soap and margarine trade is a relatively small fraction of the vast turnover. But in cosmetics, the cost of research will be proportionately much higher because it is not just a question of a desired product or the desired results which are dictated by the fancies of the customers, but of the effects on the skin, the hair, the teeth, and so forth. So the directors, in their surveys, have to decide where research can be "pushed" to the best advantage.

"Prediction" is the most difficult of all. This is not scientific fortune telling. It is the onerous responsibility of the Research Director, with his colleagues, to decide or advise on the lines of development in the future. But, commercially speaking, this is not just what the scientist sees as a desirable or advantageous line of progress. It is conditioned by the existent, latent, or creatable desires of the public. This means that the Research Director—in planning, budgeting, and recruiting for the researches which are the necessary base-line of development—has to take into account variables and imponderables for which there are no scientific measurements.

The Research Director, as an executive, is responsible for co-ordination, communication, and personnel for the six main Unilever research establishments. Direct supervision is delegated to the heads of the laboratories which are located in six different countries. World-wide Unilever research employs a staff of over 2000.

COLWORTH HOUSE

All this is a long way from the traditional practices of the companies which were the origins of what is now Unilever. They relied on the industrial and commercial arts of making and selling, with the scientists called in to justify, modify, or improve a product. Today, no product would be launched which had not been screened in terms of basic, applied, and development research before marketing was even considered.

There are, quite apart from the making and selling of products, considerations which set science squarely as a responsibility at Board level. These were exemplified by the retiring chairman, Lord Heyworth, when he said: "Another object of research which follows as a natural consequence of raising standards of living and the growth of population is the search for new raw materials that can be processed to yield ingredients for existing or novel products. Not only can this make more of those products available to satisfy increasing demands and cheapen the cost but it often releases for other essential purposes the raw materials hitherto used. The development of synthetic detergents is a striking example. If these had not been invented, the world demand for vegetable oils and fats for soap-making would at the present time be nearly a million tons a year greater than it is. Instead this extra fat is now available for food and is sufficient to provide the portion of the diet that is bought as fat each year for about 50 million people in the western world or for about 250 million people in eastern countries."

The principal parent research establishments are Port

Colworth House, Unilever unit in Bedfordshire for research on foods. Besides laboratories and pilot-scale plants, 1200 acres of surrounding land are used for research on food preservation and animal nutrition.

Sunlight (mainly soap and soapless detergents), Colworth, in Bedfordshire (food), Vlaardingen, in Holland (edible oils and fats), Edgewater, New Jersey (washing products, toilet preparations, edible oils, and other foods, with an eye to the particular needs of the United States), Isleworth (preparations for the teeth, hair, and skin), and Kempten, in Germany (concerned with paper and packaging materials).

The considerations which led to the setting up of the Colworth House Laboratories have been explained by Lord Heyworth: "Towards the end of the last war we decided upon a major expansion of our interests in foods—foods, that is, other than edible oils and fats, and we were not prepared to embark on a new enterprise like this without at the same time planning a substantial programme of research. So we concentrated the work on food research at a centre established in 1951. At Colworth, besides laboratories and pilot-scale plants, we have 1200 acres of pasture and arable land used for the horticultural research associated with the preservation of fruit and vegetables and for animal nutrition work on behalf of our animal feeding stuffs business in the United Kingdom and the Continent."

When Colworth started, it had a staff of 77. The present staff numbers 480, including 85 graduates and 180 technical assistants. (The ratio of graduates to assistants is interesting. In organic chemistry it is 1-to-1; in pig nutrition, 1-to-12; and in pilot-stage engineering, 1-to-6. The present average age of the staff is 33 years.) The research work was divided into three main groups or divisions: animal nutrition, general research, and development. These groups were in turn broken down into sections according to the disciplines, but these again were broken down into projects in which the disciplines merged.

In its early stages, the work of Colworth was largely "trouble-shooting"—finding scientific reasons why vegetables did not dry or cook properly and how to overcome the difficulty, ensuring the good behaviour of packaged soups, or shortening or extending the shelf-life of pre-packaged meats.

They were handed chicken noodle soup and told to make it acceptable in packet form to the British and Continental palates. The work they did led to the preparation of packet soups involving dehydrated vegetables. The "snags" there led to a basic re-examination of the dehydration process which, in turn, suggested many other applications—if one of the component companies could be persuaded to undertake the capital outlay on scientific improvements.

To quote Lord Heyworth again: "We must measure the amount of research effort required against the potential reward. The latter is judged by the capital expenditure needed; by the possible earnings in relation to expenditure, that is, the yield; by the number of countries and the size of the markets in which commercial development is likely to be possible and by the length of period during which it is possible that Unilever will enjoy the benefits of the work. Then, too, we must consider the speed at which a solution to the problem is likely to be found—for, while all projects are urgent, some are more urgent than others."

THE PROTEIN PROJECT

Thus basic research is a speculation. The results may be long-term but not too long! One example from Colworth may be quoted because its secondary results were important although the project itself was closed down in 1955.

This was the work on proteins. The basic research project was to develop the use of ground-nut protein and to simulate meats. This involved original research into the nature of fibres, the study of aromatics to determine meat flavours, and research into protein jellies which could be combined with the fibres to give the consistency and behaviour of animal tissue. The results were impressive—meat experts and gourmets were deceived by the cutlets, steaks, chicken-breast, and so forth. But there was "no sale". The marketing experts and the likely "takers" within the Unilever "family" were not convinced. In a Europe reacting to wartime austerity and compulsory substitutes, artificial meats which, however plausible, could not be marketed as genuine, were likely to have a poor sales appeal. They could be advantageously cheap (as margarine had been in comparison with butter half a century before) only if the demand was sufficiently great. The project was filed.

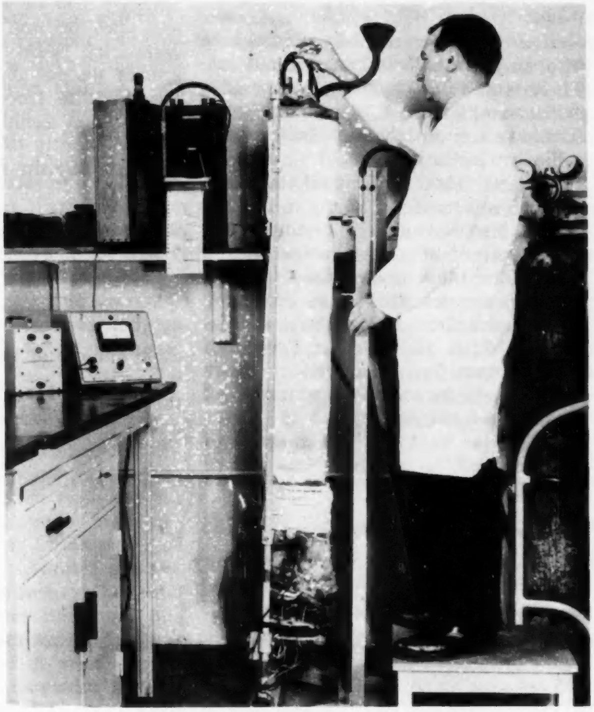
But the value of the experience was immeasurable. For one thing it fused the teams at Colworth into a composite unit. The biologists, the organic chemists, the physicists, and the food technologists had all been involved in what had been a challenging, original research. They learned to think together and, what was more, the log-book of that project provided ready-reckoner answers for problems of more commercial products.

In combination with the basic studies on dehydration, the fundamental work on proteins "paid off" in a development which has now passed over to Batchelors which Unilever had acquired in 1943. This is what might irreverently be called "Do-it-yourself-kits" which do most of the work for the housewife but still leaves her the satisfaction of having "cooked it herself".

And here one must "do a Bradshaw" to see how "good business" and "research" made their connexion. Batchelors had decided to expand—to make their name as "Batchelors Foods" instead of "Batchelors Peas". They had already gone into the market with other dried and canned vegetables and with packaged soups. To determine the nature of their expansion they made a statistical study of what people ate and of habits which were coming more and more to be dictated by the needs of the working woman or, in the higher economic brackets, of the woman without domestic help. This inquiry showed that housewives did not want merely to be tin-openers. They had little time to do daily shopping. They may or may not have had a refrigerator or a deep-freeze but they would be grateful for long shelf-life cupboard stocks. They wanted interesting meals in compact, lasting forms, quick to make—but to *make!* Packaged meals which left the culinary finesse to the woman was the answer.

And that answer coincided with research results already obtained at Colworth. They had done the work on dehydrated vegetables and how to maintain quality, consistency, and "freshness" in the products when reconstituted. They had investigated the dehydration of meats and how the texture and flavours could be regained. They had the scientific answers for a whole range of dishes and they tried them out on their colleagues, particularly those in Batchelors. The directors "bit". The decision on research in this case was taken at Batchelors board level.

Colworth research workers and Batchelors development teams co-operated. The meals were carried to the pilot-plant stage and to the production stage. Batchelors packaged them, and then displayed them in grocers' shops around Sheffield, selling them at full market price to



Gas chromatography apparatus for the isolation and identification of food flavours. The most volatile portion of the flavour of tomatoes has been investigated by separating it into sixteen fractions with this equipment.

shoppers who were "just buying something that interested them". The sales were followed up and the reactions of housewives were carefully considered. The response was gratifying. The Market Research Division of Unilever then carried out more scientific inquiries and tests.

Four packet products were consumer-satisfactory: curry and rice, spaghetti bolognaise, savoury minced beef, and creamed chicken. They were launched at the beginning of this year, starting in one television region where they were supported by commercials, and where the likely demand could be gauged and a production programme indicated for the whole country.

Science in a vast enterprise like Unilevers is a catalyst of commercial ideas and possibilities. As Lord Heyworth, the former chairman, said: "Constant contact with our research colleagues stimulates us in the quest for new ideas, keeps us lively, and saves us from the deadly sin of complacency." He might have added that it also pays substantial dividends.

THE BOOKSHELF

Captured Stars

By Heinz Letsch (*Collet's Holdings, 1960, 182 pp., 25s.*)

One of the best methods of teaching astronomy, as well as carrying out certain lines of research, is by the use of a planetarium. Most of the world's great cities have such installations, built mainly by the firm of Carl Zeiss.

This new book by Heinz Letsch is a mine of information. There is an historical introduction, followed by a description of the mechanism of a planetarium; the various refinements and projectors are described in an admirably clear manner. Famous planetaria, such as those at Milan, Jena, Tokyo, Paris, and Chicago, are then described in more detail. There are many illustrations, all of excellent quality.

This is a work of extremely high standard, and is in every way to be recommended.

P. MOORE

The Jaws and Teeth of Primates

By W. James (*London, Pitman Medical Publishing Co. Ltd, 1960, 328 pp., £5 5s.*)

Dentally, with the exception of *Daubentonia*, the primates are rather a dull lot. Studies of the shape of their teeth and jaws are exciting in so far as they illuminate anthropoid palaeontology. Mr James is the doyen of British dental research and his original work and ideas are stimulating, even though the chains of reasoning and the writing are not always convincing. It is surprising, then, that this book contains no attack on any concept of primate biology. It reads like a museum catalogue.

This is an atlas of skulls of representative species of each genus of existing primates, with notes on anatomy, distribution, live appearance, food, and habits. The photographs are good, and present three standard views of each specimen, but by being tilted from rectangular relationship to the sagittal plane they lose what use they might have for taking measurements. The braincase—the centre of interest of the primate skeleton—is obscured, and thus its relationship to the face and jaws cannot be determined.

Appendix B contains the only original material—a collection of profiles through the joint cavity of various anthropoid jaws. What a pity that this work was not taken to some conclusion. *Pithecanthropus* material may be rare, but modern man and apes are not. Objective methods of comparing fossil material with known species are not abundant. It would have been nice to record that dentists, using their special techniques, had developed a method worthy to put beside the recent biometry of Ashton, Healy, and Lipton.

A. R. NESS

Rheology: Theory and Applications Vol. 3

Ed. F. R. Eirich (*Academic Press, New York and London, 1960, xvi+680 pp., $21*)

Each volume of this book, as it appears, is eagerly welcomed by rheologists; and the demand is such that it now seems unlikely that Volume 3 will be the last. The editor has still not found it possible to insist on a unified set of symbols, even for the most widely used concepts, but this latest volume has the advantage over its predecessors that the individual chapters are followed by generally adequate tables of nomenclature. Certain chapters still reproduce rather large sections of classical treatments which most readers already have in several places on their shelves; otherwise, the massive contents supply very useful material.

It is not possible in a short review to list all the subjects and substances treated. Highlights are a short but brilliant chapter on polymer-chain models for dilute solutions by B. H. Zimm, S. Oka's "Principles of Rheometry", and B. E. Conway and Mme A. Dobry-Duclaux's essay on electro-viscous effects. Among industrial material treated are latex, printing inks, paints, inorganic glasses, concrete, and lubricants. Industrial processes include adhesion, moulding, spinning of fibres, and the theory of screw-extruders.

Criticisms of earlier volumes on the grounds that many chapters on applied rheology were largely "re-writes" of already published essays become less apt as time goes on. Only a few of the chapters in Volume 3 offend in this way.

These books are, in general, too specialised for readers who are not rheologists; but the ranks of rheologists are now increasing so rapidly that these volumes will meet an immediate and very substantial need. Looking to the future, "Eirich" will remain a classic for many years to come.

G. W. SCOTT BLAIR

Semi-Conductors

By R. A. Smith, M.A., Ph.D. (*Cambridge University Press, 494 pp., line illustrations, 65s.*)

There is no field of electrical science in which progress has been more rapid than that of the development of semi-conductors. Dr Smith is head of the Physics Department at the Royal Radar Establishment at Malvern, and he was asked to give a series of lectures on the physics of semi-conductors to the department of engineering at Edinburgh University. The book is, in effect, the manuscript of these lectures brought up to date.

This is not a book for the layman since it assumes a modest mathematical ability and a general knowledge of modern physics. With those premises, it is undoubtedly a first-rate compendium of knowledge in this field. It is clearly written and since the semi-conductor developments as we now know them date back only about twelve to fifteen years, it is possible for the author to dwell at some useful length on the complete history of semi-conductor development so that we have a broad survey of how each separate type of semi-conductor branched out from the basic principles.

After touching on the elementary properties of semi-conductor materials, the author plunges into the crystal and deals with energy levels in crystalline solids and the impurities and imperfections that may occur. He next takes us to the vital aspect of electron transport phenomena in semi-conductor crystals.

After reading these five chapters we are in a position to see how the various widely differing semi-conductor applications all arise from the same set of basic physical principles; the thermal effects in semi-conductors, the optical and high-frequency effects, and such new departures as the photo-magnetic effect are all clearly explained at this stage.

Dr Smith next gives us a lengthy chapter on the mechanism of semi-conductor operation. The diffusion of electrons and positive holes throughout the substance is patiently brought out and we are shown,

here and there, what advances we may expect in the future. There are short sections on the manufacture of semi-conductors but this is basically a theoretical treatise.

The final section deals with applications of semi-conductors, and touches on very many possible outlets for the brilliant designers who are working in this field—the photo-electric power generator, the thermo-electric refrigerator, the thermistor, and many other devices which are only now beginning to show promise of extremely important uses in the next decade.

J. H. M. SYKES

Sex Differentiation and Development

Ed. C. R. Austin. Memoirs of the Society for Endocrinology No. 7 (*Cambridge University Press, 1960, 198 pp., £2 5s.*)

This volume contains the proceedings of a conference held in London in April, 1958, "to survey the state of knowledge on sex in its various forms and implications". It deals with sex in bacteria, bees and crabs, as well as in fishes, birds, and man. In so doing it runs the risk of becoming a disconnected hotch-potch. A hotch-potch it certainly is, but the tenuous connecting thread is reinforced by the inherent fascination of the subject.

Another grave risk attends any symposium with a publication delay of two years. Every speculation or theory becomes a gamble on not being subjected to experimental test while the book is in press—or a gamble, at even longer odds, on being tested and confirmed. The section of this symposium dealing with human intersexes has gambled and in the main lost. In the course of 1959, improved methods of counting human chromosomes led to striking and far-reaching developments in our knowledge of abnormal sex-chromosome constitutions, and their role in such clinical conditions as Turner's and Klinefelter's syndromes. These advances, which must rank among the most important biological discoveries of the decade, make much of this part of the book seem out of date. If the conference had been held twelve months later, some very different stories would have been told. On the other hand one must award full marks to R. A. Beatty for the cautious and far-seeing, even prophetic, nature of his conclusions in the chapter "Chromosomal determination of sex in mammals".

Better fortune has attended that part of the book which describes attempts to control the sex ratio in animals and man. This field was a morass of conflicting reports and unsubstantiated claims in 1958; it is still a morass today. But what a tantalising morass! As a subject for research, sex ratio has the same sort of reputation among biologists that certain mountains have among superstitious mountaineers. A typical happening was Weir's finding that a high level of alkalinity in the blood of male mice was associated with a high ratio of sons to daughters in their progeny. The result was statistically highly significant. In 1958 Weir reported further work, equally significant, but this time the high ratio of sons was born to the males with the more acid blood! Yet always one feels that the age-old dream of controlling the sex ratio is just on the verge of being realised.

Certainly no loss of topicality attaches to the closing remark of the Chairman, Prof. Amoroso: "There is no problem more vital and fundamental than that of sexuality; yet there is none in which human society continues to display more ignorance and none in which it is so unwilling to discard preconceived notions."

A. MCLAREN

Science Survey I

Ed. A. W. Haslett and John St John (*Vista Books, 1960, 360 pp., illustrated, 25s.*)

This is the first volume of a series which is planned to present the state of play in all the main branches of science, at a level which the intelligent layman can understand. Every article is written by a leading specialist in the field concerned.

If "the layman" means the reader who has no training or experience in any of the sciences, then most of the chapters are surely too difficult unless this layman has outstanding intelligence. But if it means the scientist reading about a subject outside his own speciality, who has a little background knowledge of most fields, then for him the book is almost perfect. Every chapter is clear, authoritative, and packed with up-to-date information.

Most of the chapters deal with "pure" science, but three are concerned with purely technological problems: one on the Mohole project and two on rocket motors. The only reason for choosing these subjects seems to be their likelihood of appearing in the news fairly constantly during the next few years. Otherwise the selection of topics is admirable and covers a fascinatingly wide range—from fundamental particles to courtship behaviour, and from tailor-made polymers to the geology of Antarctica.

This is a very promising beginning to a series. Let us hope that later volumes can maintain the same standard.

C. S. O'D. SCOTT

UNESCO Source Book for Science Teaching

(*Unesco and Educational Productions Ltd., 223 pp., 15s.*)

In schools in many parts of the world, the apparatus and laboratory facilities normally required for such science teaching are not available. Since science plays so important a part in modern education, UNESCO has published the present volume (a compilation of the work of experienced teachers of science from many countries) in which clear guidance is given to intending science teachers on how the apparatus difficulty can be overcome. After an opening chapter of suggestions on teaching method, there are sixteen chapters of simple experiments in all branches of science—Biology, Geology, Astronomy, Meteorology, Chemistry, Physics, and Anatomy. Of the hundreds of experiments described, all can be carried out with the simplest of materials without recourse to the scientific firms. There is, in fact, a list of suitable everyday materials and the places from which they can normally be obtained. Much ingenuity has been shown in the devising and selection of experiments, almost all of which can be set up and performed by the pupils themselves. The experiments are lucidly described and, where necessary, illustrated by clear diagrams. The final chapter contains useful hints for science teachers, giving instructions for making up the solutions and other adjuncts to experimental work. The book ends with nine appendices containing tables of physical and chemical constants and information regarding the supplies of scientific books, periodicals, visual aids and apparatus, in many countries of the world.

E. S. JEFFS

Atlas der Phasenkontrast-Haematology

By H. Rind (*Akademie Verlag, Berlin, 1958, 392 pp., 1259 figs, £7*)

As indicated by the title, this atlas is strictly confined to phase contrast microphotographs of normal and pathological cells of the blood and bone marrow from adults, children, and newborns. There is an introduction to the optical basis of phase contrast microscopy, and brief clinical notes accompany the pictures. All were taken from wet sealed preparations; some illustrate the changes occurring during the hours following the removal of the specimen from the patient. The technical standard of photography and reproduction is generally high. With about 1200 illustrations and the stringent limitations to phase contrast observations only, one could expect an almost complete survey of the field, including some relevant aspects of comparative haematology. However, this is not so. There is no reference to comparative aspects, the lipoidoses are only represented by Gaucher's disease, and malaria is the only tropical disorder dealt with. Toxoplasmosis and the interesting phenomena of lupus erythematosus are not mentioned. The author subscribes wholeheartedly to the idea that the late erythroblast extrudes its nucleus without explaining why this phenomenon can be observed in wet preparations and smears of aspirated material but is not observed in the most carefully prepared sections or preparations of bone marrow.

The purpose of an atlas of this kind is to show all the different stages of cell types and their variations as far as any significance can be attributed to them, but in this atlas there is far too much repetition from which no further information can be obtained as to cellular behaviour and the response to pathogenic agents or therapeutic measures. The picture of living, normal, and pathological cells is fascinating even to the experienced investigator and this may explain why the author has been carried away by their beauty and was unable to select from his extensive collection of good microphotographs.

W. JACOBSON

Soviet Moon Rockets: Soviet Booklet No. 62

(*Published by Soviet Booklets, London. Price 1s.*)

Anyone who hopes to find details of the performance of Russian rockets will be disappointed in this book. The only figure given for the total weight of a rocket at launch, for example, refers to the American *Juno II*. Apart from this reticence, and the familiar and repeated insistence on Soviet superiority in every field, this is a very readable account of the flights of *Luniks II* and *III*.

P. HOWARD

LETTERS TO THE EDITOR

The Smoking Controversy

Sir:

There really is now very little doubt that lung cancer and cigarette-smoking are significantly connected, and it is a reasonable explanation that smoking is a direct cause of the disease. . . .

But even granting that lung cancer in smokers is a matter of direct cause and effect, the situation cannot be a simple one. Seven out of eight of the heaviest smokers remain unaffected, and some of them live to a ripe old age, while a number of non-smokers do get it. And the amount smoked, although it affects the *probability* of getting the disease, has *little* effect upon when it starts. A young man will not get lung cancer however much he smokes, though he may have consumed more tobacco before he is thirty than a light smoker has by the age of 60, who now runs an appreciable risk.

All this suggests that intrinsic factors have a part to play in carcinogenesis as well as extrinsic factors like smoking, and these intrinsic factors are most likely to have a genetical component. In other words, some people are born more "cancer-prone" than others, and are more likely to produce a growth in response to the same extrinsic stimuli (see Goodhart, C. B., 1959, *The Practitioner*, vol. 182, p. 578).

If this is what is happening, it means

that a man who is cancer-prone is quite likely to develop lung cancer in late middle age if he is a smoker; but if he is not, he will probably get the disease somewhere in his body sooner or later, unless he dies of something else in the meanwhile. But a person who is not cancer-prone is unlikely to get it in his lungs, or anywhere else, however much he smokes.

A consequence of this hypothesis is that if more of the cancer-prone are smoking and so going to die of lung cancer, then fewer of them will survive to get it elsewhere. There is some evidence that this is so. The Registrar General's Returns for England and Wales show that the annual lung cancer death-rate for men aged 65–70 was 2·962 per 1000 for the period 1951–5, compared with 0·345 for 1931–5, an eightfold increase. And yet the total cancer death-rate (including lung cancer) for that age-group had increased only 3·9%, from 8·943 to 9·291, over the same twenty years. The very striking rise in lung cancer has been matched by a rather similar fall of 2·224 at the other sites.

Also, the incidence of all forms of cancer together should vary much less between different groups and classes of the population than does the incidence of particular forms of the disease, which may result from differential exposure to extrinsic carcinogenic factors. In fact, there is a lot of variation in cancer between different regions and occupations. For example, lung cancer is particularly prevalent in towns, and in London especially in eastern and riverside districts. This has been supposed to be the effect of atmospheric pollution as well as of possible differences in smoking habits. But it is curious that in rural areas, and in those parts of London where lung cancer is less frequent than expected, there is often some excess of the disease in other parts of the body (see Stocks, P., 1947, "Regional and Local Differences in Cancer Death Rates", H.M. Stationery Office). This is to be expected on the cancer-proneness hypothesis, where an excess of one form should be matched by a deficiency of others.

A striking example of this is in the incidence of different forms of cancer in the two sexes. For instance, in 1959, 18,181 men died of lung cancer compared with 2882 women. Women still do not smoke as much as men, but it seems unlikely that a sixfold difference in mortality could be due solely to different smoking habits. Certainly cigarette consumption has been increasing relatively more for women than for men, but this is not matched by any proportionate rise in the rate of increase in female mortality: the annual increment for women is now about 100, and it is over 1000 for men. But the *total* cancer mortality for the two sexes is much closer; in 1959, 51,783 men and 45,334 women died from all forms of cancer together. The male excess of 15,299 lung cancers has been reduced to 8850 in the total, but this is because women have a much higher mortality from cancer of the breasts and genitalia than do men. Furthermore, since the prognosis for mammary and uterine cancers is quite good, which it is not for cancer in the lungs, the actual incidence of the disease in the two sexes may be closer than these death-rates would suggest. It looks as though a cancer-prone man is going to get the disease in his lungs if he is a smoker, or somewhere else if he is not, while a cancer-prone woman is likely to get it in the breast or uterus whether or not she smokes.

On the cancer-proneness hypothesis, therefore, a smoker who dies of lung cancer would probably have developed a growth somewhere else sooner or later, even if he had never smoked in his life. That is, of course, not easily proved but it should be possible to get some idea whether it is likely to be sooner rather than later, when the full data of the Medical Research Council's inquiry into the smoking habits and mortality of doctors are made available for investigation.

What is needed is an estimate of the number of years by which the lung-cancer deaths of the smokers would have to be assumed to have been advanced, allowing for the age-specific mortality from other causes, in order to equate the total cancer death-rate of the smokers with that of the non-smokers. If the figure is found to be ten years or so, then the cancer-proneness hypothesis has little practical significance, since the expectation of life at the age at which most lung-cancer victims die is not much above that, whether they are cancer-prone or not. If the loss turns out to be only a year or two, that is still an arguement against smoking but it will at least give the smoker an idea of what it is he is risking in the way of expectation of life as well as the risks that he runs. A good estimate of the *risk* is that a heavy smoker has one chance in eight of dying of lung cancer. But does this mean that he has one chance in eight of losing a couple of years of his life, or five years or ten? It makes quite a difference, and this is a piece of information that could be and should be provided.

C. B. GOODHART

University Museum of Zoology, Cambridge

William Thomas Brande

Sir:

I am collecting information concerning the life and work of William Thomas Brande (1788–1866) who was Professor of Chemistry at the Royal Institution from 1813 to 1852 and Secretary to the Royal Society from 1816 to 1826.

I should be glad to hear of any letters, manuscript material, etc., of which your readers may have information.

E. E. IRONMONGER

Senior Lecturer in Mathematics, Westminster College, North Hinksey, Oxford

Science versus Babel

Sir:

Perhaps I may be allowed to reply to the letter of Mr R. Spathaky on the subject of international auxiliary languages and their usefulness in overcoming language barriers in science, and at the same time to explain my own views a little more fully than I did in my article, "Science versus Babel" in the June issue of DISCOVERY.

Mr Spathaky's arguments are, it seems to me, of the type that is so often put forward by proponents of the various languages in discussions on this subject—in effect, "My language is better than yours" (though, incidentally, he proves nothing by comparing the Interlingua and Interglossa versions of two simple sentences). This kind of attitude will get us nowhere. The unfortunate truth is that the proponents of international auxiliary languages are caught up in a vicious circle, which goes like this: people don't learn Interlingua (or Esperanto, or anything of the kind) because there is not sufficient published in this language to make it worth while, and there isn't sufficient published in Interlingua, etc., to make it worth while because people don't learn it.

There is a way out of this situation, and I think it is for some international body, such as UNESCO, to consider the question of international auxiliary languages, to select whichever it finds to be the best, or if necessary to design a new one, and for all those concerned with such languages to accept the UNESCO decision. As I wrote in my article, at the present time linguists cannot agree on the language to use; I think the world will remain obstinately uninterested in the auxiliary language question as long as linguists continue to quarrel among themselves. . . .

J. JACKSON

London

SCIENCE ON THE SCREEN

Prague Film Congress

The XIV Congress of the International Scientific Film Association in Prague brought together a remarkable selection of films from East and West.

The Dutch ingeniously filmed the movements of the larynx by supporting one that had been dismembered in a frame and then simulating blood flow with air pressure and muscular impulses with strings. The East Germans showed the field and current distribution in photoconductors by using crystals that were electrically charged in liquid air.

Psychological experiments with monkeys that were reared with surrogate mothers were shown in *The Nature and Development of Affection* from America.

Only film could have provided such unique records as Calabek's beautiful time-lapse study of *Autonomous Movements in Plants* or the fascinating Belgian account of the *Geophysical Expedition to the Nyiragongo Volcano in 1959*, surely the best film of its kind yet made.

The Education Section was treated to a variety of films of high standard such as the East German sound colour and the Bulgarian silent black-and-white films on liver fluke. Poland sent a coloured study called *Winged Divers* which showed how certain insects adapted to life in the air and in water. Shell's *The Living Soil* was designed to teach farmers basic facts about nematodes and a West German film showed time-lapse studies of cloud movement.

About 250 films were projected over a period of eight days for the 240 delegates that came from twenty-five countries. With the large output of science films during recent years, it was inevitable that producers would enter territory already explored. One Hungarian production on carnivorous plants called *Living Traps* and another on marine life off the Adriatic coast entitled *With Lenses Under the Sea* raised memories of sequences in Shell's classic film *The Rival World* and British Transport's more recent masterpiece *Between the Tides*. Yet none of this was needless duplication for good film makers never see a subject in exactly the same terms. What were incidental examples in *The Rival World* and *The Living Soil* by Shell became main themes for a Belgian and Hungarian producer; the Japanese with their vivid and poetic sense of composition and the aid of cinemascope managed to say almost the last word on steel production.

Three radical types of commercial screening were demonstrated by the Czech hosts at the Congress: "Laterna Magika", a novel technique for combining a live stage performance with film on three screens; "Polyecran", the use of eight screens of different sizes to produce remarkable kaleidoscope impressions; and the Soviet "Circlerama", with ten projectors focused on ten screens arranged in a circle. A specially prepared Laterna Magika presentation will be made in London shortly.

COMING EVENTS

NOVEMBER

1–3 New York
International Congress on Experimental Mechanics
R. Guernsey, Jr, Society of Experimental Stress Analysis, General Engineering Lab., General Electric Co., Schenectady 5, N.Y.

1–16 New Delhi, India
International Electrochemical Commission
American Standards Association, 70 E. 45th Street, New York 17

3–5 Paris
35th Congress of the French Society of Orthopaedics and Traumatology
Secretary, Société Française d'Orthopédie et de Traumatologie, 120 Boulevard St-Germain, Paris 6

7–10 Galveston, Texas
30th Annual International Meeting of the Society of Exploration Geophysicists
Mr Walter B. Lee, c/o Gulf Oil Corporation, Drawer 2100, Houston 1, Texas

7–13 Tokyo
International Symposium on Numerical Weather Prediction
American Meteorological Society, 3 Joy Street, Boston 8, Massachusetts

14–18 London
London Medical Exhibition
British and Colonial Druggists Ltd, 194 Bishopsgate, London, E.C.2

25 London
National Conference on High Speed Photography
R. F. Saxe, Queen Mary College, London, E.1

DECEMBER

1–16 London
3rd Session of the Commission for Climatology
World Meteorological Organisation, Campagne Rigot, 1 Avenue de la Paix, Geneva

7–9 London
Winter Conference of the Royal Photographic Society of Great Britain
Mr D. Brownbill, Technical Service Department, Ilford Ltd, Roden Street, Ilford, Essex, England

19–20 London
Conference on Statistical Mechanics
Organising Secretary, The Physical Society, 1 Lowther Gardens, London, S.W.7

26–30 Havana
7th Inter-American Congress of Psychology
G. M. Gilbert, Psychology Department, Long Island University, Brooklyn 1, N.Y.

JANUARY

10–11 Bristol University
Conference on Physics of Polymers
Organising Secretary, The Physical Society, 1 Lowther Gardens, London, S.W.7

MARCH

15–17 Cologne
International Congress on Medical Photography and Cinematography
Deutsche Gesellschaft für Photographie, Neumarkt 49, Cologne, Germany

APRIL

10–15 London
1st International Congress on Metallic Corrosion
Lt-Col Francis J. Griffin, Society of Chemical Industry, 14 Belgrave square, London, S.W.1

12–14 Philadelphia
International Symposium on Agglomeration
Metallurgical Society of the AIME, 29 West 39th Street, New York 18, N.Y.

17–20 Bristol, England
Annual Conference of the Ergonomics Research Society
O. G. Edholm, Medical Research Council, Hampstead, London, N.W.3

MAY

7 Ghent
13th International Symposium on Crop Protection
Prof. Ing. J. Van den Brande, Institut Agronomique de l'Etat, Coupure Gauche 233, Ghent, Belgium

THE PROGRESS OF SCIENCE

(continued from page 463)

FAO ATTEMPTS TO END CONFUSION ON FISH

How many sturgeon are caught in the Mediterranean each year? It is almost impossible to say, the Food and Agricultural Organisation has discovered, because what is known as the sturgeon in English-speaking countries may be known by a multiplicity of names in Egypt, Israel, Tunisia, and Turkey. Difficulties of one sort or another exist with the classification of many other fish in this body of water. Some fish have no names at all. A particular type of sole has a special name in Italian but not in the languages of any of the other eleven Mediterranean nations. This situation has made it virtually impossible for fisheries experts to get a clear picture of the size and scope of the fishing industry in that region and has emphasised the need for standardisation. In an attempt to accomplish this, the FAO has published a catalogue that contains sketches of 250 fish along with their chief characteristics, species, order, and family. It includes eighteen kinds of rays (beginning with the guitar fish and ending with the devil fish) and twenty-eight types of sharks (from the "Darkie Charlie" to the six-gilled shark).

PROGRESS IN AUTOMATION, EAST AND WEST

Soviet scientists and engineers are fervent believers in automation in any form, whether it is automatic assembly, the optimal operation of power stations or large electrical networks, automatic translation from one language to another, or merely the dispensing of soda-water. The progress they have made in control and automation was in evidence at the First Congress of the International Federation of Automatic Control that was held recently in Moscow. From the material presented by Soviet delegates, personal discussions, and an inspection of research and development work going on, it appears they have achieved a marked superiority in the analytical fields—that is in theory and mathematical analysis. The Institut Avtomatiki i Telemechaniki, governed by the Soviet Academy of Sciences, has greatly contributed to their superiority in this field, as have the institutes in Moscow, Leningrad, Kiev, and elsewhere.

One important index of the amount of effort going into automation and control in the U.S.S.R. is the number of books being published on the subject. Although some translations have appeared, the true extent of Soviet literature in this field has not been fully appreciated. The amount printed in Russian is believed to be equal to or larger than the total in all the Western languages. This mammoth effort clearly indicates the role automation is likely to play in the future development of industry in the U.S.S.R.

The components developed in the Soviet Union seem to be on a par with those produced in other industrial countries, but there has been some outstanding progress on both sides. The Russians have developed pneumatic devices that are capable of doing almost anything an electronic circuit can do. They have even developed air-operated memory units and air-operated analogue and digital computers. Although such devices work much more slowly than their electronic counterparts, they are much cheaper and can readily be used as an extension of existing equipment, often eliminating pneumatic-electric transducers.

In the Western countries, on the other hand, there has been striking progress on the miniaturisation of components for applications where weight and space must

be kept to a minimum. New techniques in film deposition and printed circuitry have also resulted in greater reliability.

Despite the advances in the U.S.S.R., automation and control are still being used to a greater extent in the Western countries. However, application is lagging behind theoretical work everywhere.

SHORTAGE OF GOVERNMENT SCIENTISTS

The latest report of Her Majesty's Civil Service Commissioners shows an improvement in recruitment in several categories, but so far as scientists are concerned the news this year is more disturbing than it has ever been.

The Commissioners have been unable to fill an adequate proportion of vacancies in the scientific class. Although this has also been the case in previous years, the situation has worsened during the 12-month period ending March 31 and, in the Commissioner's words, "now gives rise to grave disquiet". Although there has been an increase in the number of applications for posts as Scientific Officers and Senior Scientific Officers, the "quality of these candidates . . . has noticeably deteriorated". In the grade of Scientific Officer specifically, there is a particularly high number of unfilled vacancies among physicists, engineers, chemists, and mathematicians. There were only five applicants for every four vacancies during the year and some 80% of the vacancies remained unfilled. In the Senior Scientific Officer grade, there were only twice as many applicants as vacancies, with about one-third of vacancies remaining unfilled.

A comparison with the Home Civil Service is revealing; there were nearly twelve times as many applicants as vacancies at the administrative level and all the vacant posts were filled.

The position of mechanical and electrical engineers who are classified in the "works group" and not in the scientific class proper is no better. There were only five applications for every two vacancies and some 75% of all vacancies remained unfilled, with the shortage most marked among electrical and electronic specialists.

The fact that the Government (the nation's major employer of scientists) is unable to man their establishments is very serious.

Sir Frederick Brundrett, a member of and scientific adviser to the Civil Service Commission, went out of his way recently to argue that the Civil Service offers the scientist pay and career prospects as good as he will find anywhere. He attributed the shortfall to "rotten publicity".

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